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Instructions: W0010051

Product: DA starting motor  
Part no.: 0 001 133 ..

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Continue: I01/1

## SPECIAL FEATURES

These instructions describe repair procedures for the following pre-engaged-drive starters of type DA

- 12 V/0.9 kW

0 001 133 ...

This type of starter features a radial shaft oil seal in the drive end shield.

Older versions are provided with an end seal in the drive end shield and a thrust ring at the collar of the meshing pinion and are described in separate instructions.

Continue: I02/2

## SPECIAL FEATURES

A new parts set is always to be used on assembly.

Lubricate in line with lubrication schedule before and during assembly.

Prior to assembly, use three-square scraper to remove all residual paint from fitting and sealing surfaces.

Continue: I03/1

## SPECIAL FEATURES

If the starting motor is painted after assembly, make sure that paint does not ingress into the interior of the starting motor through the vent holes.

Seal vent holes before painting.

Always re-open vent holes after painting to ensure proper operation of starting motor.

Continue: I03/2

## SPECIAL FEATURES

The overrunning-clutch drive is subject to a high degree of wear and is always to be replaced.

The bushings in the drive-end bearing and commutator end shield are always to be renewed.

Continue: I04/1

## SPECIAL FEATURES

There is no means of checking the solenoid switch which would provide reliable information on long-term trouble-free operation.

It is therefore advisable to renew the solenoid switch when repairing the starting motor.

On installation, approx. 0.5 g of Loctite 577 (5 994 090 000) is to be applied to the threads of the solenoid switch bolts.

Continue: I04/2

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## SPECIAL FEATURES

Starting motors of this type have various vehicle-specific drive-end bearings which may differ considerably from the version illustrated. This however in no way affects disassembly, checking, repair and assembly.

Continue: I01/1

## STRUCTURE, USAGE

PC user prompting:

Position cursor on button and confirm.

Microcard user prompting:

User prompting is provided on every page e.g.:

- Continue: I 17/1

- Continue: II 18/1      Fig.: II 17/2

Brief instructions may include several rows of coordinates.

I../. = first coordinate row

II../. = second coordinate row

III../. = third coordinate row

etc.

.../1 = upper coordinate half

.../2 = lower coordinate half

Continue: I01/1

## GENERAL

Unless otherwise stated, the voltages indicated in these instructions are DC voltages.

AC voltages are marked by the symbol " \* ".

Continue: I06/2

## GENERAL

Expert repairs are only possible using the prescribed tools and measuring instruments, which are in perfect working order. We therefore recommend that exclusive use be made of the tools listed.

The use of incorrect and unsuitable tools and testers can lead to injury and may damage the product concerned or its component parts.

Continue: I07/1

## GENERAL

Only use replacement parts given in the service parts list for the starting motor concerned.

Proper functioning presupposes use of the lubricants specified in these instructions, both prior to and during assembly.

Absolute cleanliness is to be ensured when performing repair work.

Continue: I01/1

## SAFETY MEASURES

### Component cleaning:

Armature, commutator end shield, solenoid switch and overrunning-clutch drive are only to be cleaned using compressed air (max. 4 bar) and a clean cloth. Use is never to be made of liquid cleaning agents.

Other parts such as stator frame and drive-end bearing can be washed out with commercially available cleaning agent which is not readily flammable. Take care not to inhale vapours. Components must be re-lubricated or re-greased in line with lubrication schedule.

Continue: I08/2

## SAFETY MEASURES

Danger of fire: Take care to avoid naked flames and sparking.

### ATTENTION:

Make sure parts which have been cleaned are thoroughly dried, as gases subsequently forming in the sealed starting motor can lead to an explosion.

Always use the listed tools. Injuries cannot be precluded if use is made of incorrect and unsuitable tools and testers.

Continue: I09/1



## SAFETY MEASURES

Always heed the following safety regulations:

- \* German Order governing the use of flammable liquids (VbF).
  - \* Accident prevention regulations for electrical systems and equipment.
  - \* Safety regulations for the handling of chlorinated hydrocarbons:
    - For companies: ZH 1/222
    - For employees: ZH 1/129
- issued by the German industrial liability insurance associations (central association for accident prevention and industrial medicine), Langwartweg 103, 53129 Bonn.

Continue: I09/2

## SAFETY MEASURES

Outside Germany, pay attention to appropriate local regulations.

Skin protection:

To avoid skin irritation when handling oil and grease, apply hand cream before starting work and wash cream off when finished with soap and water.

Continue: I01/1

## TESTERS, EQUIPMENT, TOOLS

All tools required for repairing starting motors of type DA are listed in the following.

Some of the tools needed have to be improvised in line with the drawings.

The type designation is given in parentheses for tools which used to be ordered on this basis.

Continue: I10/2

## TESTERS, FIXTURES, TOOLS

Interturn short-circuit  
tester with test probes: 0 986 619 110

Test prods: 0 986 619 101  
(Old version: 0 986 619 114)

Alternator tester  
WPG 012.00: 0 684 201 200  
(alternatively, Motortester)

Magnetic measurement  
stand: 4 851 601 124

Dial indicator: 1 687 233 011

Mandrel press: comm. avail.

Continue: I11/1

TESTERS, EQUIPMENT, TOOLS

Clamping support:	0 986 619 362 (KDAW 9999)
Torque wrench (0...70 Nm):	comm. avail.
Torque meter (0.15...0.80 Nm):	0 986 617 206 (KDAL 5485)
Assembly sleeve:	0 986 619 417
Disassembly sleeve:	0 986 619 418

Continue: I11/2

TESTERS, FIXTURES, TOOLS

Holding device:	0 986 619 420
Collet chuck, comprising	
* Base:	0 986 619 408
* Collet for pinion with 8 teeth:	0 986 619 409

Continue: I12/1

TESTERS, EQUIPMENT, TOOLS

Bushing puller:	0 986 617 243 (KDAL 5493)
Spring collet for bushings diameter 12.5 mm:	0 986 617 246 (KDAL 5493/0/3)
Pressing-in mandrel with plate washer for bushings diameter 12.5 mm:	0 986 617 212 (KDAL 5486)

Continue: I12/2

TESTERS, FIXTURES, TOOLS

Tailstock chuck with Morse taper 2 for clamping diameter 5...45 mm for holding armature when turning down:	0 986 619 156 (KDAW 9987)
Sliding caliper:	comm. avail.
Three-square scraper:	comm. avail.
Small cape chisel:	comm. avail.
V-blocks (2x):	comm. avail.

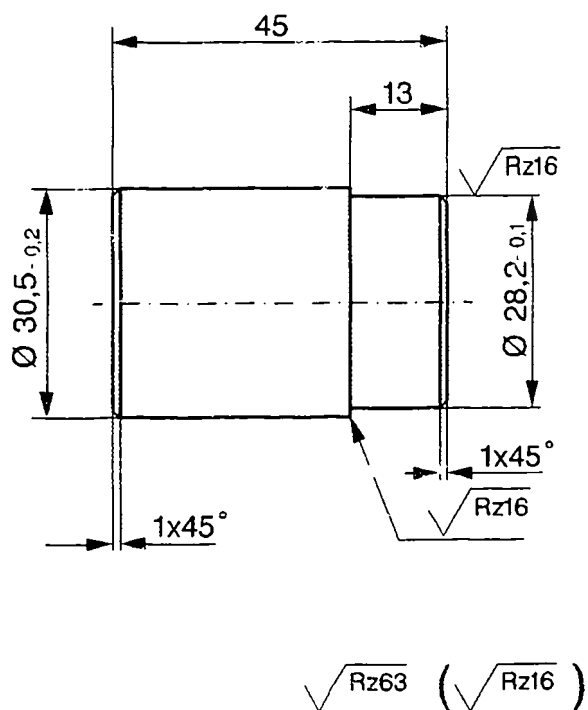
Continue: I13/1

# TESTERS, EQUIPMENT, TOOLS

Pressing-out mandrel  
for bushing  
in drive-end bearing: to be improvised

Continue: I14/1 Fig.: I13/2

KMS00454



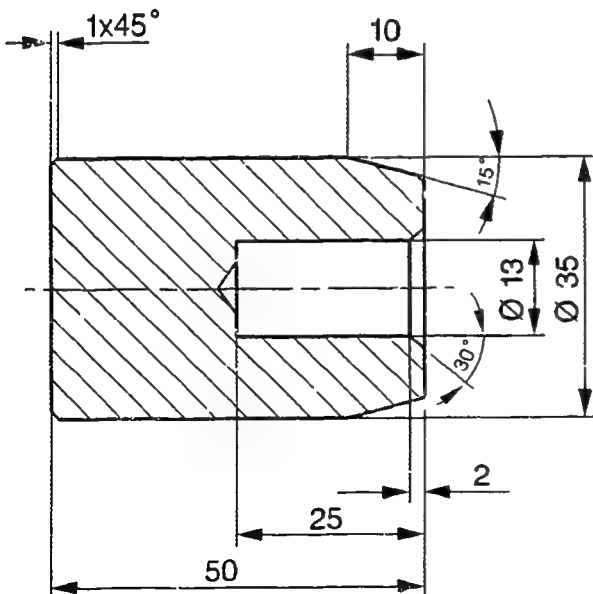
TESTERS, FIXTURES, TOOLS

Centering sleeve for  
brush holder:

Own make

Continue: I01/1 Fig.: I14/2

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$\sqrt{Rz03}$

## TEST SPECIFICATIONS AND SETTINGS

Commutator - minimum  
diameter: 33,5 mm

Radial run-out  
- Commutator: < 0,02 mm

Armat. axial clearance: 0,1...0,6 mm

Continue: I15/2

## TEST SPECIFICATIONS AND SETTINGS

Armature braking torque: 0,3...0,4 Nm

Clutch overrunning  
torque: 0,1...0,2 Nm

Carbon brush  
wear dimension x: < 14 mm

Total pinion travel a: 12...15 mm

Continue: I16/1

## TEST SPECIFICATIONS AND SETTINGS

Solenoid-switch  
pull-in voltage:

5...8 V

Solenoid-switch resistances

- Pull-in winding: 0,3...0,4 Ohm
- Holding winding: 1,5...1,7 Ohm

Continue: I01/1



## TIGHTENING TORQUES

Attachment of end plate of commutator end shield:	1,5...2,0 Nm
Attachment of commutator end shield and drive-end bearing:	5,5...6,0 Nm
Solenoid-switch attachment:	4,5...6,0 Nm
Brush-holder connection, term. 45:	7,0...9,0 Nm
Connection, term. 30:	7,0...9,0 Nm

Continue: I01/1

## LUBRICANTS/LUBRICATION SCHEDULE

### General:

Commutator and carbon brushes are to be kept free of grease and oil.

Greased parts are to be degreased before re-lubricating them.

New bushings must be moistened prior to installation using suitable oil.

Oil VS 13 834-Öl: 5 962 260 000

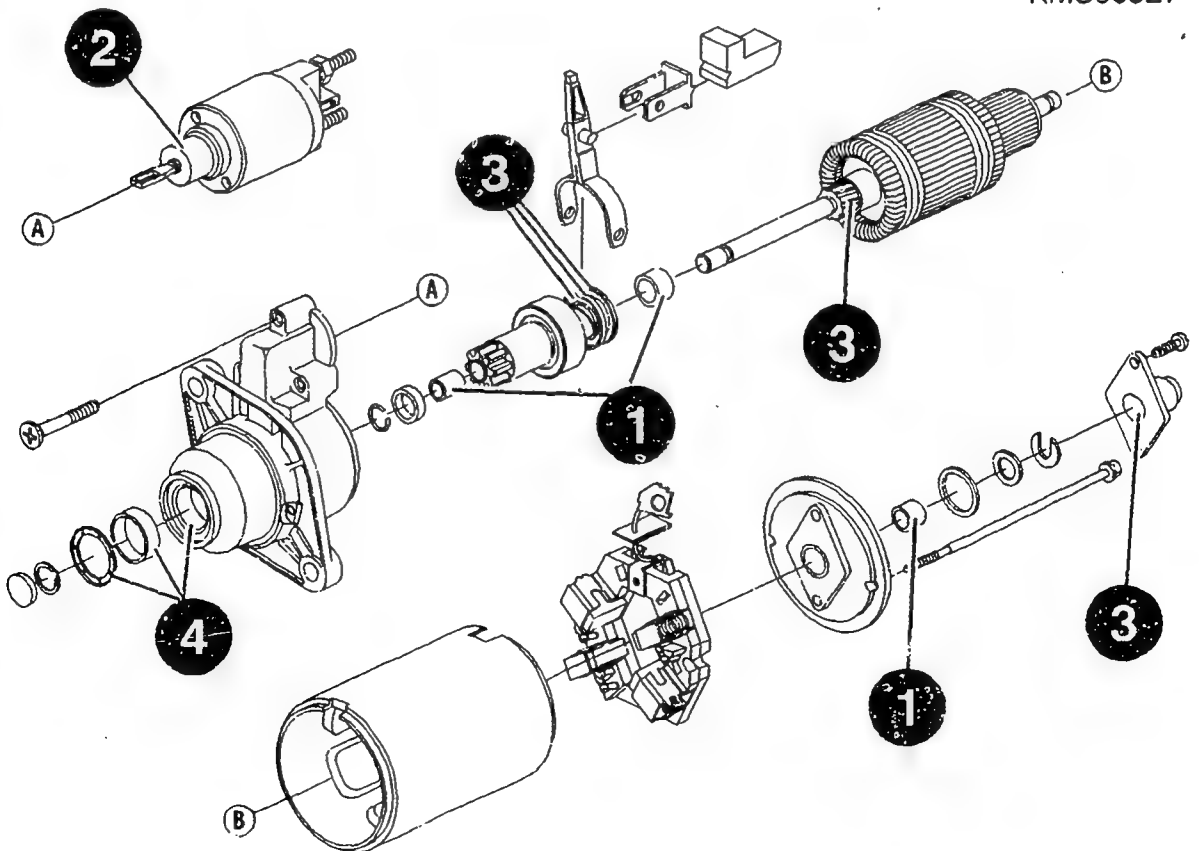
Continue: I19/1

# LUBRICANTS/LUBRICATION SCHEDULE

1	=	Oil VS 13834-Ö1	5 962 260 000
2	=	Grease VS 16634-Ft	5 990 260 000
3	=	Grease VS 18036-Ft	5 997 098 000
4	=	Grease VS 18099-Ft	5 997 287 000

Continue: I01/1 Fig.: I19/2

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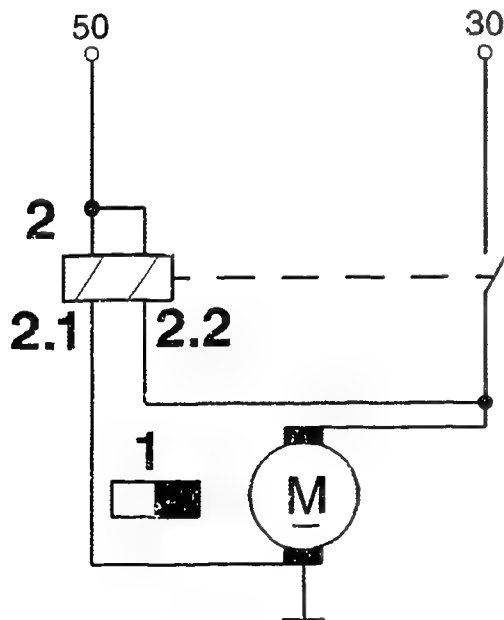


# CIRCUIT DIAGRAM

- 1 = Exciter field (permanent magnet)
- 2 = Solenoid switch
- 2.1 = Holding winding
- 2.2 = Pull-in winding

Continue: I01/1 Fig.: I20/2

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## STARTER DISASSEMBLY TABLE

Disassembling solenoid switch	I22/1
Disassembling bearing end plate	I25/1
Disassembling commutator end shield	I26/1
Disassembling drive end shield	I28/1
Disassembling armature with overrunning clutch	II01/1
Disassembling cap	II02/1
Disassembling overrunning clutch	II03/1

Continue: I01/1

# STARTING-MOTOR DISASSEMBLY

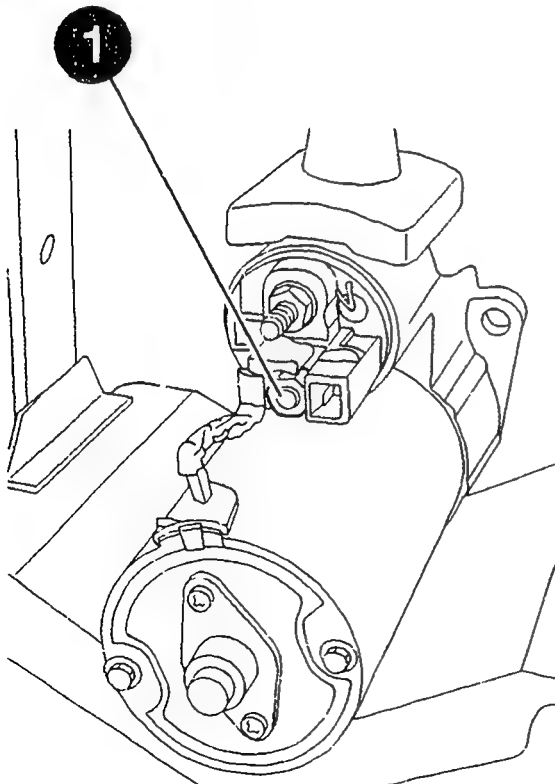
## Solenoid-switch disassembly

Clamp starting motor in clamping support. Unfasten connection (1) of excitation winding at solenoid switch.

Clamping support: 0 986 619 362

Continue: I23/1 Fig.: I22/2

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## STARTING MOTGR DISASSEMBLY

### Disassembling solenoid switch

Mark position of solenoid switch.  
Unfasten solenoid switch bolts.

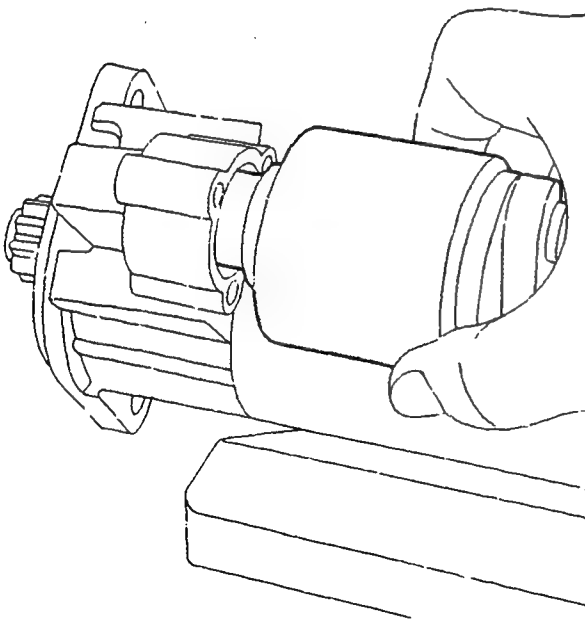
### DANGER OF ACCIDENT

The pretensioned return spring causes the solenoid switch to be pressed down by the switch armature.

Pull solenoid switch off switch armature. Pay attention to return spring in solenoid switch armature.

Continue: I24/1 Fig.: I23/2

KMS00396



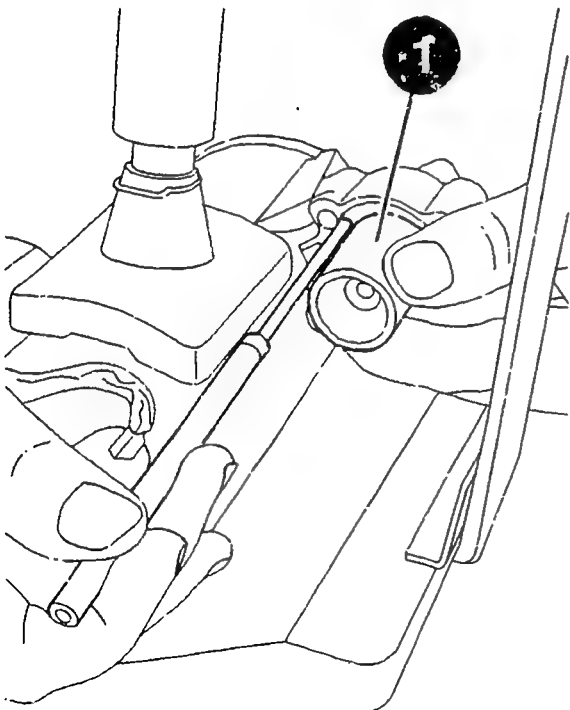
## STARTING MOTOR DISASSEMBLY

### Disassembling solenoid switch

Use suitable tool to pull back engaging lever and disengage solenoid switch armature (1) at engaging lever.

Continue: I21/1 Fig.: I24/2

KMS00397





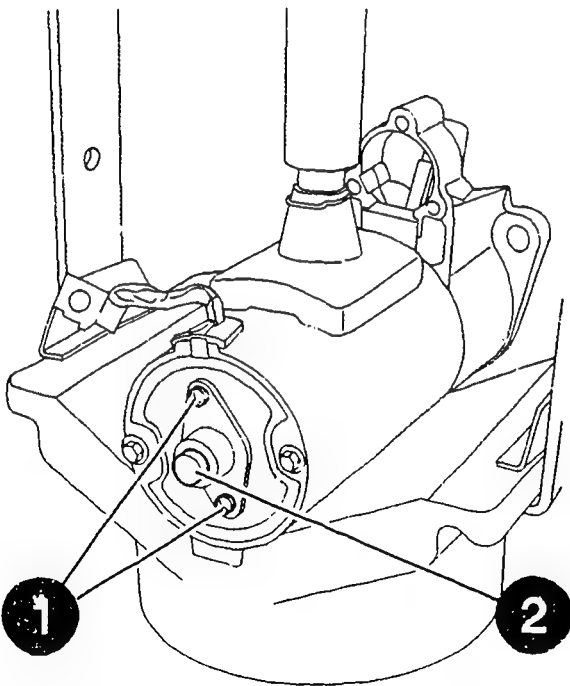
## STARTING MOTOR DISASSEMBLY

### Disassembling bearing-end plate

Unfasten bolts (1) of bearing-end plate (2). Remove bearing-end plate with sealing ring.

Continue: I21/1 Fig.: I25/2

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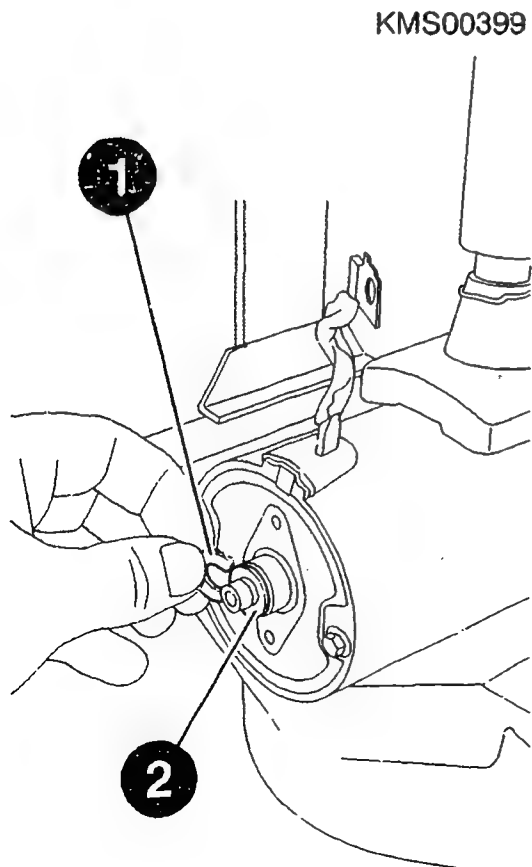
## STARTING MOTOR DISASSEMBLY

### Disassembling commutator end shield

Remove positioning washer (1) of armature shaft and shim (2).

NOTE: If there is any burr at the armature shaft groove, start by removing this burr with an oilstone or the like.

Continue: I27/1 Fig.: I26/2



## STARTING MOTOR DISASSEMBLY

Disassembling commutator end shield

Unfasten bolts (1).

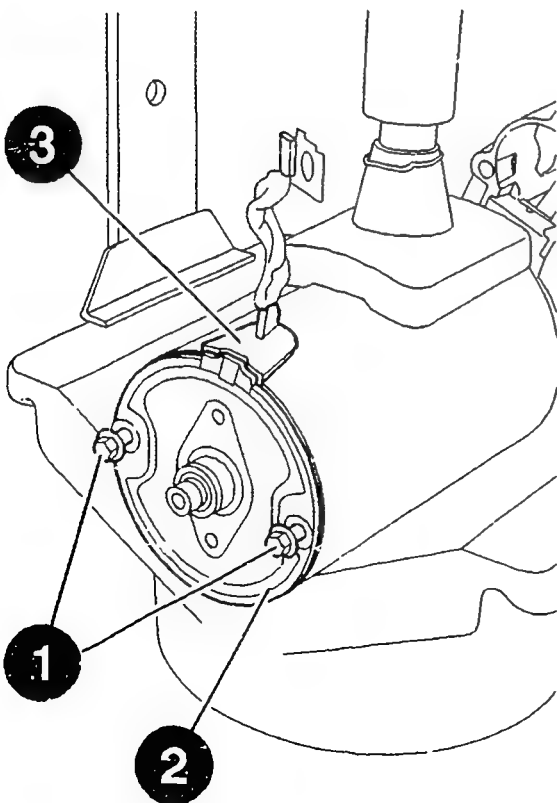
Remove commutator end shield (2) from stator frame, taking care not to damage gasket (3).

### DANGER OF INJURY

The drive-end bearing is not fixed in position with respect to the stator frame.

Continue: I21/1 Fig.: I27/2

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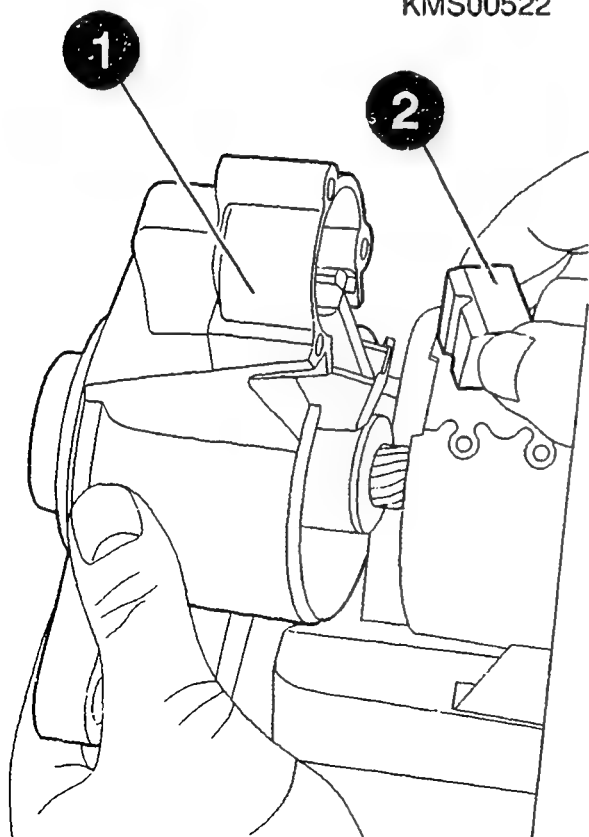
## DISASSEMBLING STARTER

### Disassembling drive end shield

Pull off drive end shield (1) and in doing so take out rubber seal (2).

Continue: I21/1 Fig.: I28/2

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## DISASSEMBLING STARTER

Disassembling armature with overrunning clutch

Attach centering sleeve to armature shaft from commutator end.

Pull armature (1) with overrunning clutch (2) out of stator housing (3) towards drive end shield side.

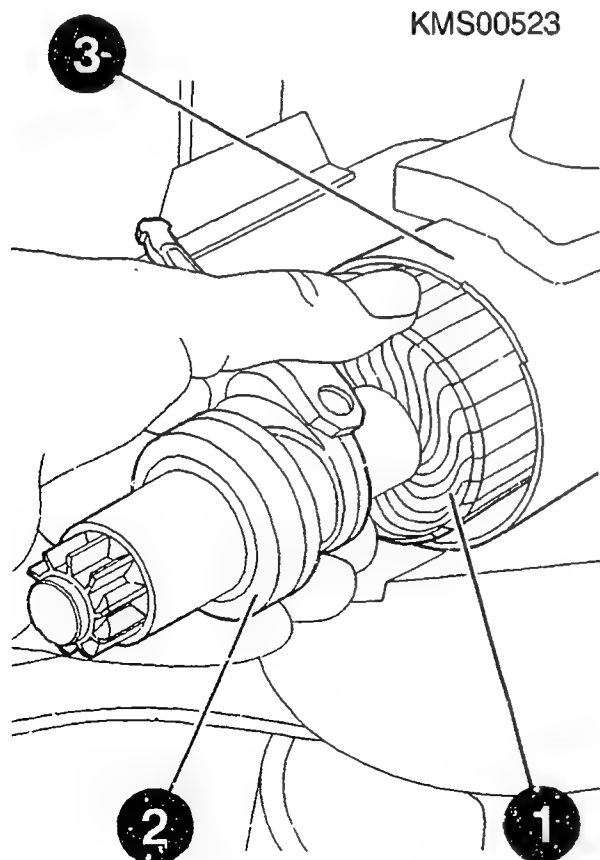
At the same time, insert centering sleeve into brush holder.

**NOTE:** Carbon brushes must rest fully on centering sleeve.

Centering sleeve/  
brush holder:

improvised

Continue: I21/1 Fig.: II01/2



## DISASSEMBLING STARTER

### Disassembling cap

Clamp armature (1) complete with overrunning clutch (2) in clamping support.

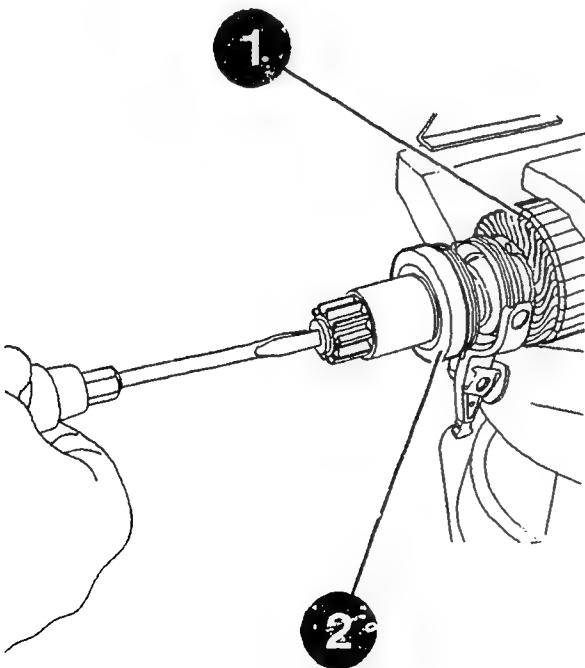
Jam suitable tool into edge (see Fig.) of cap by tapping gently with a plastic-headed hammer and prise off cap.

**ATTENTION: DANGER OF INJURY**

Clamping support: 0 986 619 362

Continue: I21/1 Fig.: II02/2

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## STARTING MOTOR DISASSEMBLY

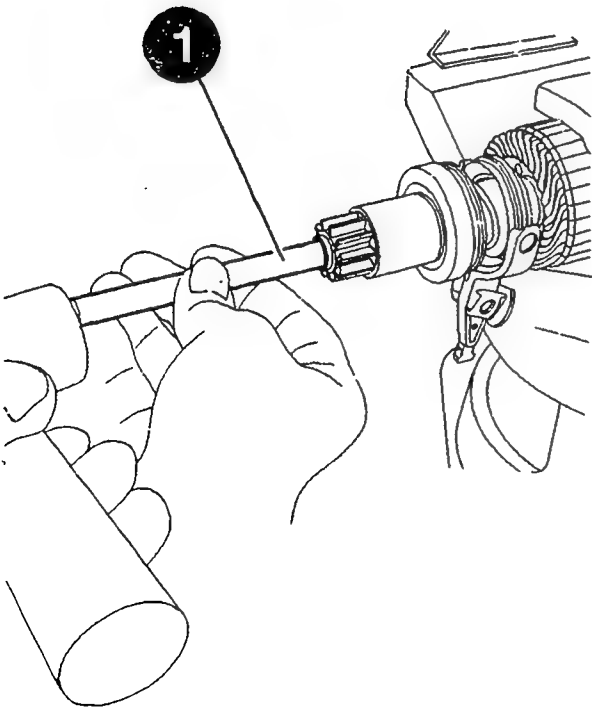
### Disassembling overrunning-clutch drive

Slip disassembly sleeve (1) over output shaft and position on stop ring. Knock back stop ring by tapping firmly (plastic-headed hammer) on disassembly sleeve.

Disassembly sleeve: 0 986 619 418

Continue: II04/1 Fig.: II03/2

KMS00462



## STARTING MOTOR DISASSEMBLY

### Disassembling overrunning-clutch drive

Use suitable tool to remove snap ring (1) from output shaft.

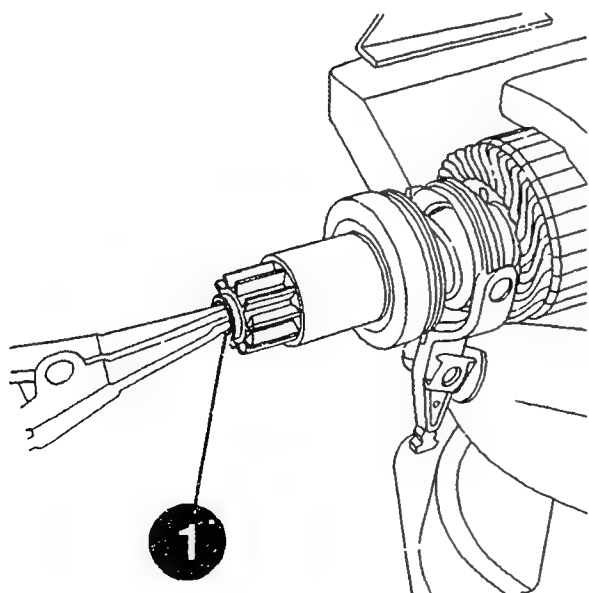
Take care not to damage output shaft.

#### DANGER OF INJURY

The pretension may cause the snap ring to spring off the output shaft.

Continue: II05/1 Fig.: II04/2

KMS00463





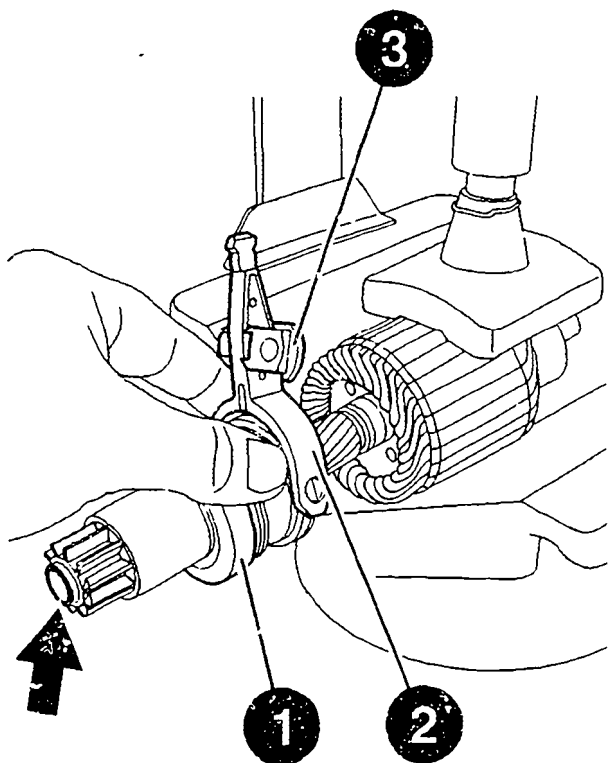
## STARTING MOTOR DISASSEMBLY

### Disassembling overrunning-clutch drive

Remove overrunning-clutch drive (1) with engaging lever (2) and mount (3) from output shaft. Pay attention to stop ring in pinion hole (see arrow).

Continue: I01/1 Fig.: I105/2

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## COMPONENT CLEANING

### Component cleaning:

Armature, commutator end shield, solenoid switch and overrunning-clutch drive are only to be cleaned using compressed air (max. 4 bar) and a clean cloth. Use is never to be made of liquid cleaning agents.

Other parts such as stator frame and drive-end bearing can be washed out with commercially available cleaning agent which is not readily flammable. Take care not to inhale vapours. Components must be re-lubricated or re-greased in line with lubrication schedule.

Continue: II06/2

## COMPONENT CLEANING

Danger of fire: Take care to avoid naked flames and sparking.

### ATTENTION:

Make sure parts which have been cleaned are thoroughly dried, as gases subsequently forming in the sealed starting motor can lead to an explosion.

Continue: II07/1

## COMPONENT CLEANING

Always heed the following safety regulations:

- \* German Order governing the use of flammable liquids (VbF).
  - \* Accident prevention regulations for electrical systems and equipment.
  - \* Safety regulations for the handling of chlorinated hydrocarbons:
    - For companies: ZH 1/222
    - For employees: ZH 1/129
- issued by the German industrial liability insurance associations (central association for accident prevention and industrial medicine), Langwartweg 103, 53129 Bonn.

Continue: II07/2

## COMPONENT CLEANING

Outside Germany, pay attention to appropriate local regulations.

Skin protection:

To avoid skin irritation when handling oil and grease, apply hand cream before starting work and wash cream off when finished with soap and water.

Continue: I01/1

## TESTING, REPAIR TABLE

Checking pinion	II09/1
Checking drive-end bearing	II10/1
Checking commutator end shield	II16/1
Checking overrunning-clutch drive	II18/1
Checking armature	II20/1
Checking commutator	II23/1
Checking carbon-brush wear	II26/1
Checking stator frame	III01/1
Checking solenoid switch	III02/1

Continue: I01/1

## COMPONENT TESTING AND REPAIR

### Testing pinion

Meshing pinion and overrunning-clutch drive are subject to considerable wear. Overrunning-clutch drive is therefore always to be replaced.

Continue: II08/1

## COMPONENT CHECKING AND REPAIR

### Checking drive end shield

Radial shaft oil seal and bushing of drive end shield are always to be replaced.

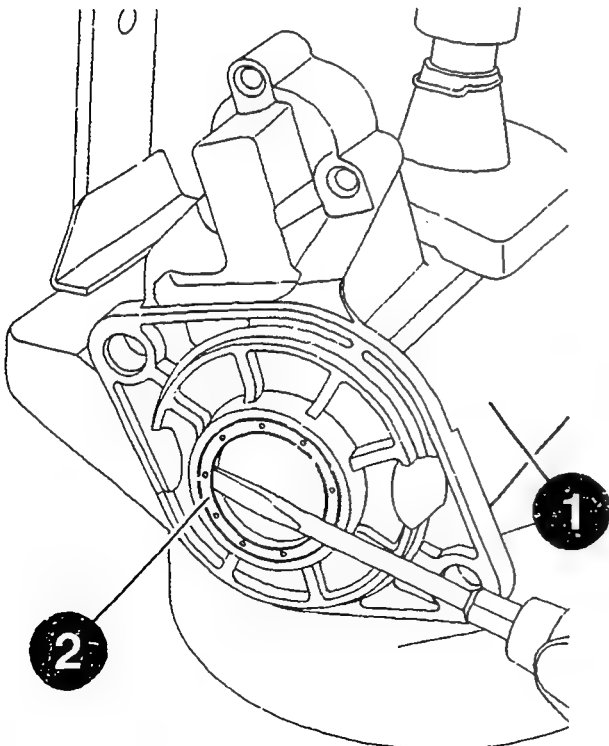
Removing radial shaft oil seal:  
Clamp drive end shield (1) in clamping support.

Use suitable tool to prise out radial shaft oil seal (2).

Clamping support: 0 986 619 362

Continue: II11/1 Fig.: II10/2

KMS00516



## COMPONENT TESTING AND REPAIR

### Checking drive-end bearing

#### Bushing removal:

Use pressing-out mandrel (1) to press out bushing inwards.

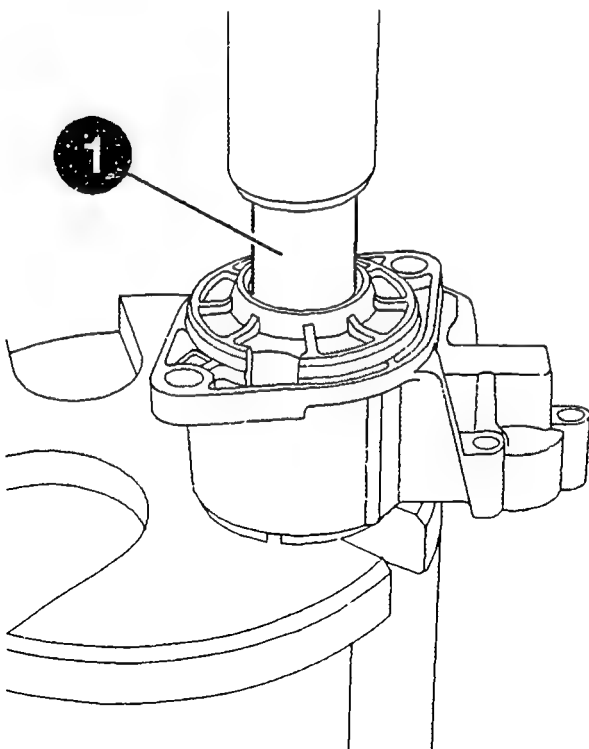
Mandrel press:

comm. avail.

Pressing-out mandrel: to be improvised

Continue: II12/1 Fig.: II11/2

KMS00412



## COMPONENT CHECKING AND REPAIR

### Checking drive end shield

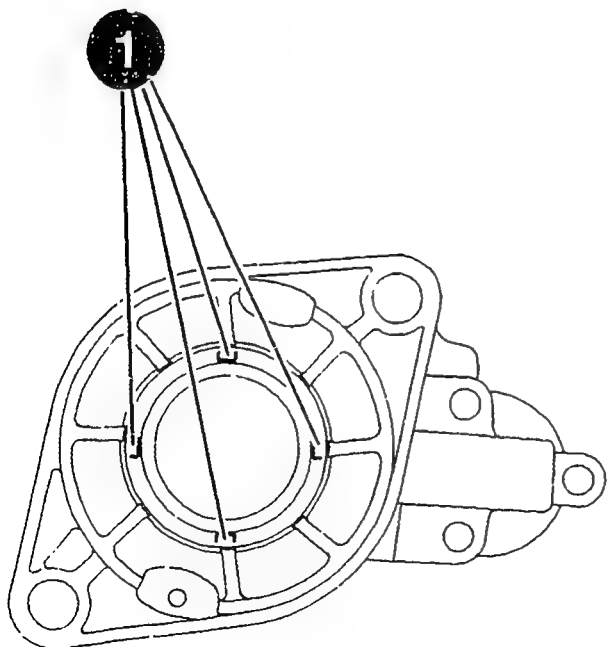
After removing radial shaft oil seal and bushing, use three-square scraper to carefully remove projecting caulking material (1).

**ATTENTION:** Take care not to damage fitting surfaces of bearing and oil seal seats.

Three-square scraper:            comm. avail.

Continue: II13/1    Fig.: II12/2

KMS00413





## COMPONENT TESTING AND REPAIR

### Checking drive-end bearing

#### Bushing installation:

Make direct use of mandrel of mandrel press to carefully press bushing from inside into drive-end bearing such that it is flush.

**ATTENTION:** Pockets of new bushing must be completely filled with grease.

Mandrel press:

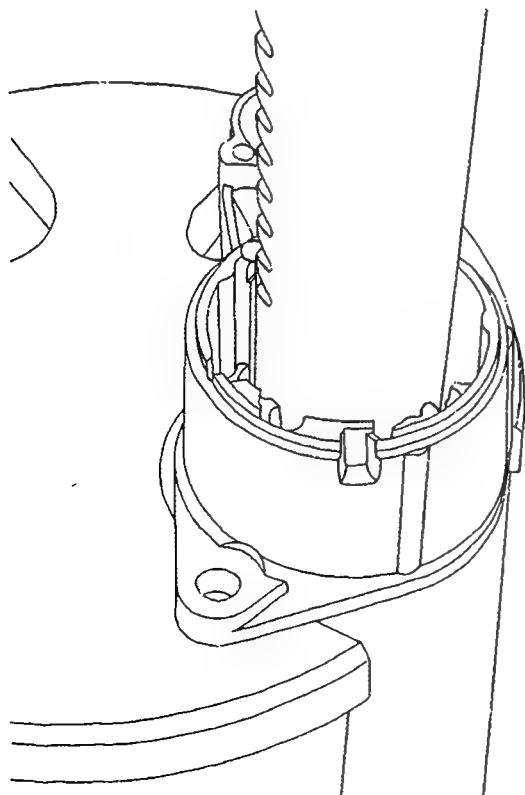
comm. avail.

Grease VS 18099 Ft:

5 997 287 000

Continue: II14/1 Fig.: II13/2

KMS00414



## COMPONENT CHECKING AND REPAIR

### Checking drive end shield

Installing radial shaft oil seal:

Fill seat of radial shaft oil seal in drive end shield with grease.

Press home radial shaft oil seal (1) by hand in drive end shield.

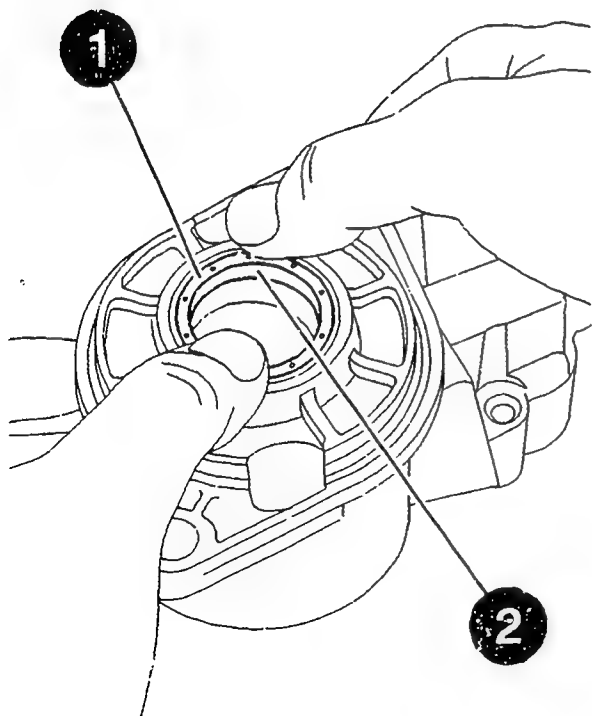
ATTENTION: Open side of radial shaft oil seal with groove (arrow) must be facing upwards.

Remaining free space (2) between radial shaft oil seal and bushing must be completely filled with grease.

Grease VS 18099 Ft: 5 997 287 000

Continue: II15/1 Fig.: II14/2

KMS00517



## COMPONENT CHECKING AND REPAIR

### Checking drive end shield

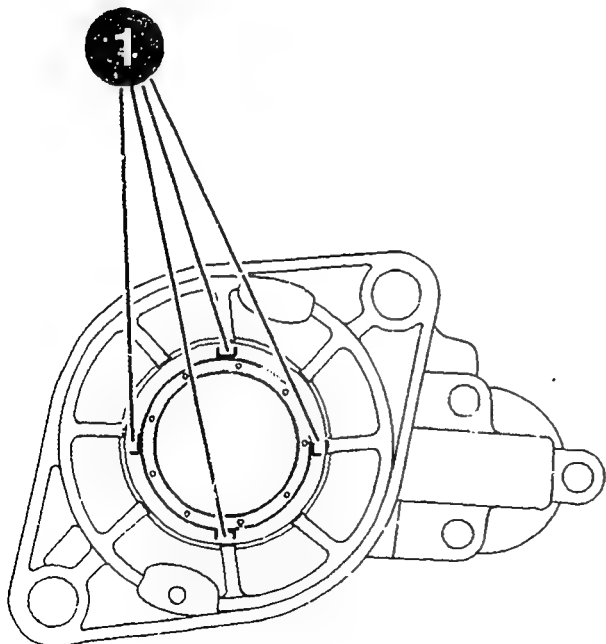
Installing radial shaft oil seal  
(continued):

Use small cape chisel to caulk drive end shield at four locations (1) offset in each case by 90 so as ensure tight radial shaft oil seal fit. Take care not to damage machined seat of radial shaft oil seal. Remove surplus grease after assembly.

Small cape chisel: comm. avail.

Continue: II08/1 Fig.: II15/2

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## COMPONENT TESTING AND REPAIR

### Checking commutator end shield

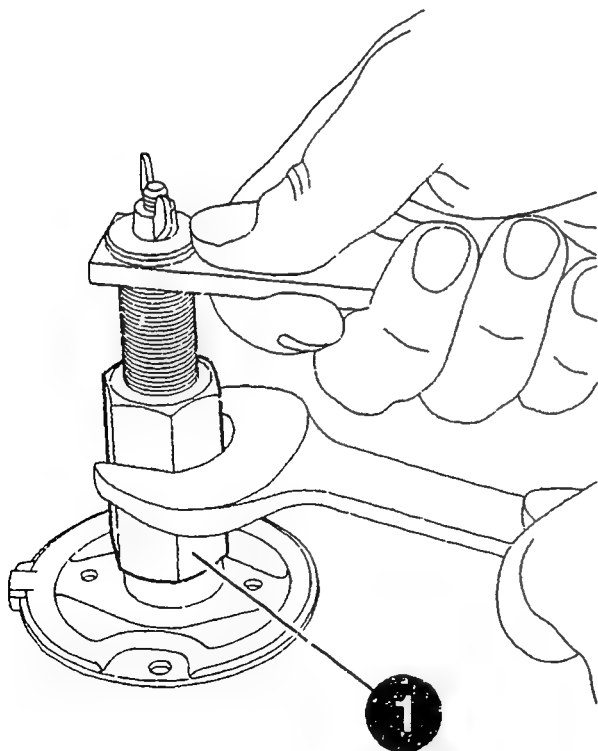
Check bushing for damage and scoring.  
Replace if necessary.

Removal: Use puller (1) and spring  
collet to pull bushing out of  
commutator end shield.

Puller:	0 986 617 243
Spring collet diameter 12.5 mm:	0 986 617 246

Continue: II17/1 Fig.: II16/2

KMS00417



## COMPONENT TESTING AND REPAIR

### Checking commutator end shield

Installation: Use pressing-in mandrel (2) to press new bushing (1) from inside (see Fig.) into commutator end shield such that it ends 0.2...0.4 mm before outer collar of commutator end shield.

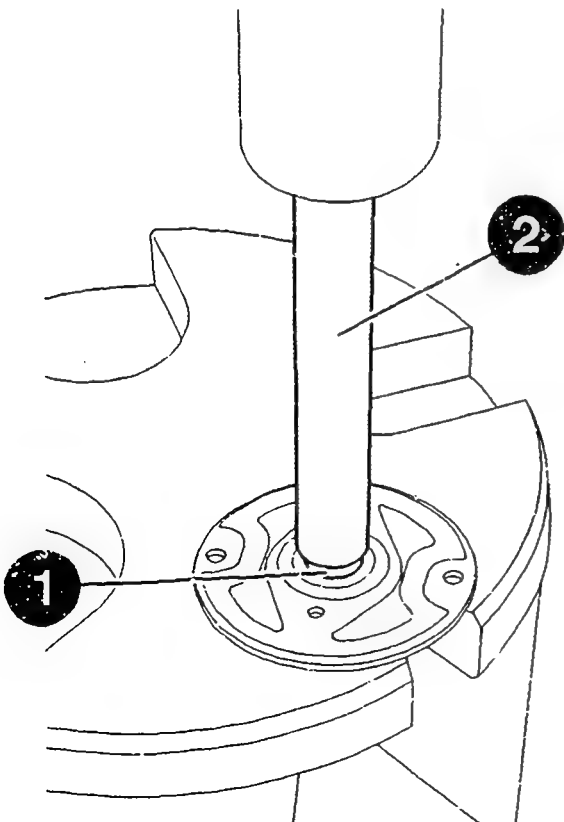
If necessary, use old bushing to press in to required dimension.

**ATTENTION:** New bushing must be moistened beforehand with suitable oil.

Mandrel press:	comm. avail.
Pressing-in mandrel:	0 986 617 212
Oil VS 13 834-01:	5 962 260 000

Continue: II08/1 Fig.: II17/2

KMS00418



## COMPONENT TESTING AND REPAIR

### Checking overrunning-clutch drive

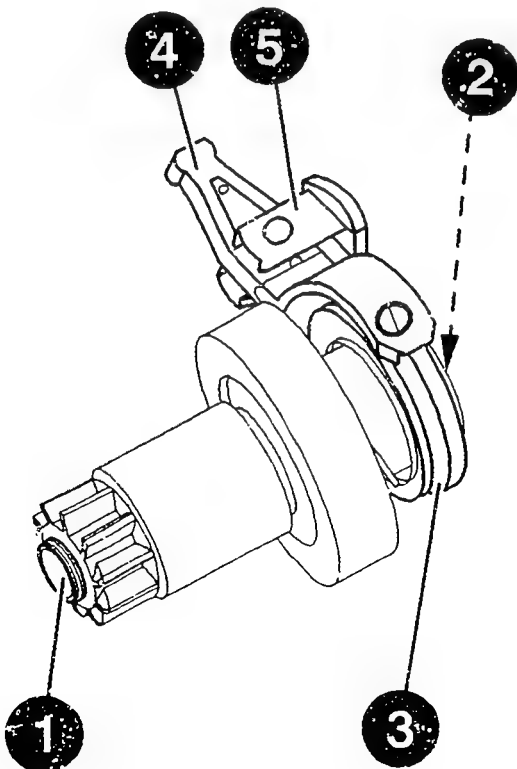
Pinion, bushings (1), spiral spline (2) and driver edges (3) of overrunning-clutch drive are subject to a high degree of wear.

The overrunning-clutch drive is thus always to be replaced.

Also replace engaging lever (4) and its mount (5).

Continue: II19/1 Fig.: II18/2

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## COMPONENT TESTING AND REPAIR

### Checking overrunning-clutch drive

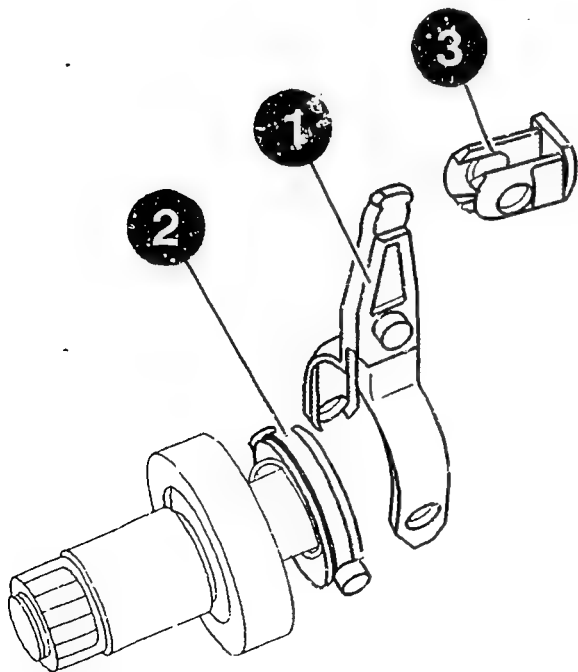
Engage new engaging lever (1) at driver (2) on overrunning-clutch drive.

Engage new mount (3) at engaging lever with open end facing pinion.

NOTE: Fig. shows disassembled engaging lever and mount.

Continue: II08/1 Fig.: II19/2

KMSC0481



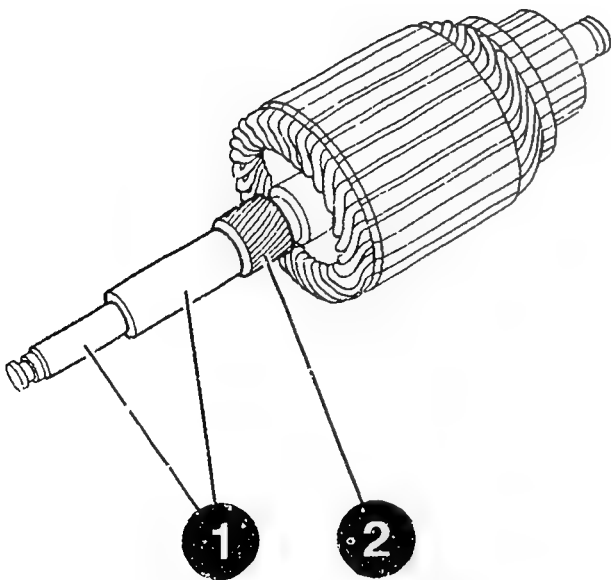
## COMPONENT TESTING AND REPAIR

### Checking armature

The entire armature is to be replaced if one of the bearing surfaces (1) on the output shaft or the spiral spline (2) is worn or damaged.

Continue: II21/1 Fig.: II20/2

KMS00465





## COMPONENT TESTING AND REPAIR

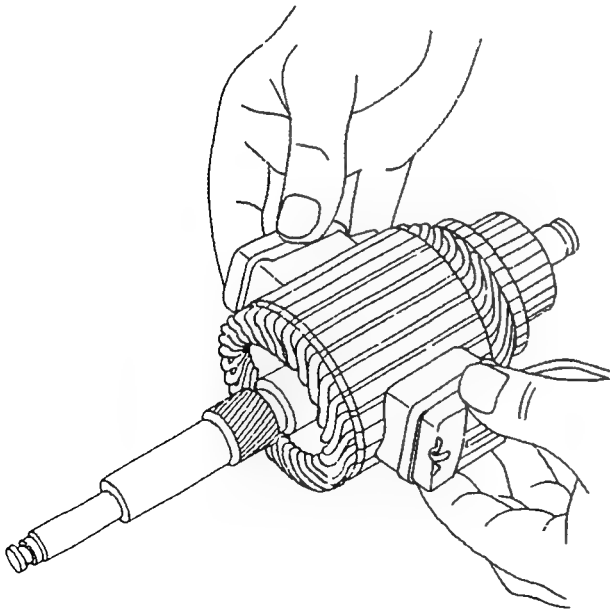
### Testing armature

Check armature for interturn short circuit using tester and test probes.

Interturn short-circuit  
tester with test probes: 0 986 619 110

Continue: II22/1 Fig.: II21/2

KMS00484



## COMPONENT TESTING AND REPAIR

### Checking armature

Use tester and test prods to check armature for short to ground and continuity (black laminations are an indication of an open circuit).

#### Interturn-short-circuit

tester: 0 986 619 110

Test prods: 0 986 619 101

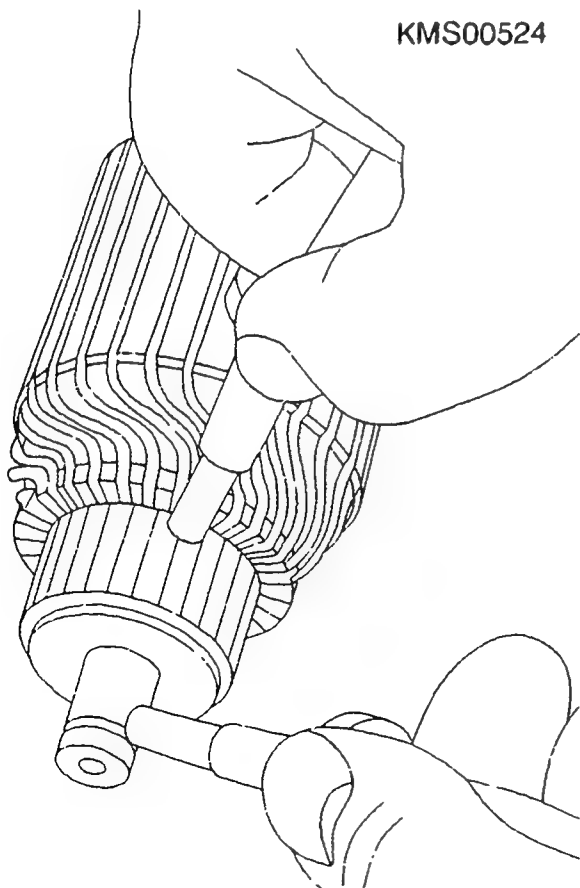
Test voltage for checking short to ground: 40 V\*

Continuity test voltage: 40 V\*

\* = AC

Continue: II08/1 Fig.: II22/2

KMS00524



# COMPONENT TESTING AND REPAIR

## Testing commutator

Check commutator concentricity.  
If radial run-out is outside stated  
range, commutator must be turned  
down.

Magnetic measurement

stand:

4 851 601 124

Dial indicator:

1 687 233 011

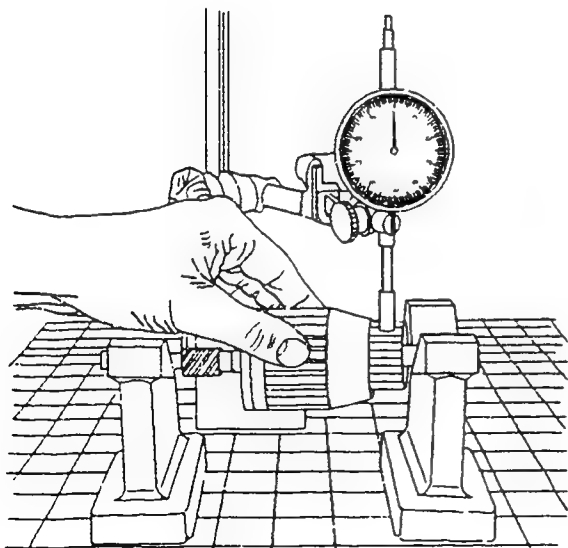
Radial run-out

- Commutator:

< 0,02 mm

Continue: II24/1 Fig.: II23/2

KMS00192



# COMPONENT TESTING AND REPAIR

## Testing commutator

Turning down involves positioning armature in three-jaw chuck and tailstock rest (1). The max. machining thickness is 0.03 mm.  
Pay attention to minimum diameter.

Tailstock rest with  
Morse taper 2:

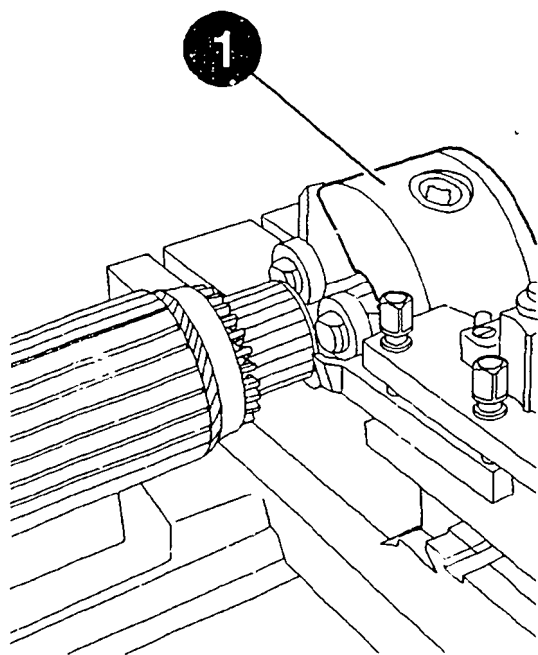
0 986 619 156

Minimum diameter:

33,5 mm

Continue: II25/1 Fig.: II24/2

KMS00193



## COMPONENT TESTING AND REPAIR

### Checking commutator

After turning down, the commutator segment insulation must be sawn out to a depth of 0.8 mm with a suitable tool.

After sawing out, turn down commutator again and check armature for interturn short circuit and short to ground. Pay attention to diameter.

The carbon-brush wear dimension is also to be checked with turned-down armature.

Continue: II25/2

## COMPONENT TESTING AND REPAIR

The brush holder is to be replaced if necessary.

Interturn-short-circuit tester: 0 986 619 110

Minimum diameter: 33,5 mm

Test voltage when checking for short to ground: 40 V\*

\* = AC

Continue: II08/1

## COMPONENT TESTING AND REPAIR

### Checking carbon-brush wear

Wear dimension is to be checked with armature fitted.

Clamp armature (1) in clamping support.

Pull brush holder (2) with locating sleeve (3) out of stator frame and slip onto armature shaft.

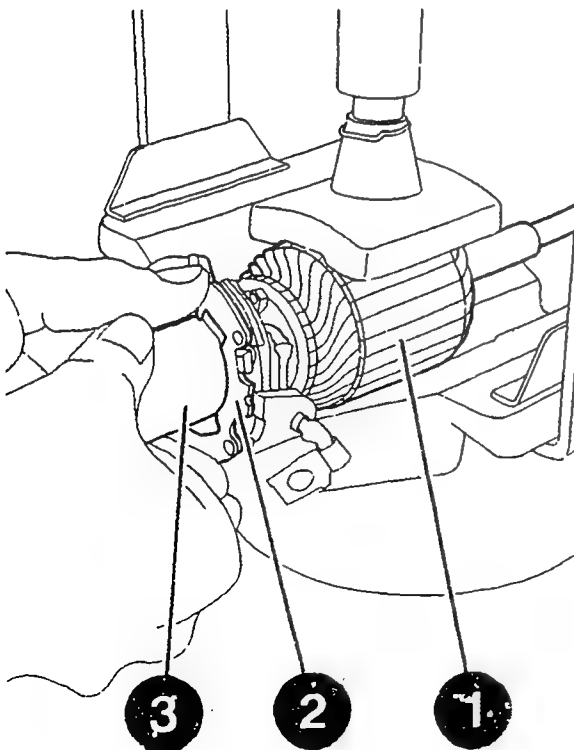
Push brush holder (2) from locating sleeve (3) onto commutator and remove locating sleeve (3).

Clamping support:

0 986 619 362

Continue: II27/1 Fig.: II26/2

KMS00466



# COMPONENT TESTING AND REPAIR

## Checking carbon brush wear

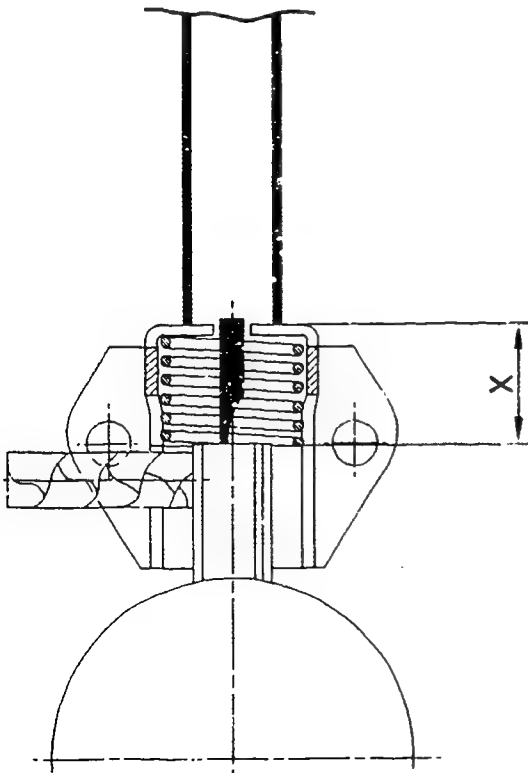
The carbon-brush wear dimension  $x$  is measured with a depth gauge from the top edge of the cartridge-type brush holder to the top edge of the carbon brush.

Carbon-brush  
wear dimension  $x$ :

< 14 mm

Continue: II28/1 Fig.: II27/2

KMS00393



## COMPONENT TESTING AND REPAIR

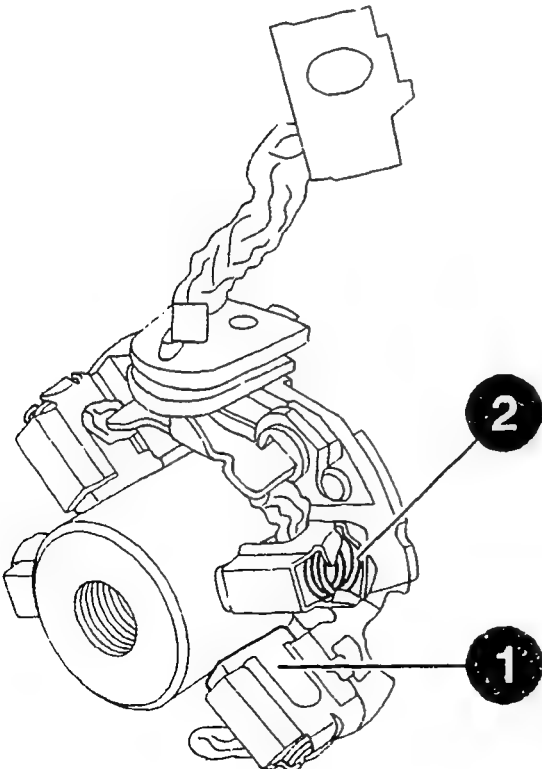
### Checking carbon brush wear

The entire brush holder must be replaced if the carbon brushes (1) are worn down to the minimum length or damaged or if the helical compression springs (2) are worn.

Exclusive use is to be made of replacement parts from the list applying to the type of starting motor concerned.

Continue: II08/1 Fig.: II28/2

KMS00424





## COMPONENT TESTING AND REPAIR

### Checking stator frame

Check stator frame for damage.

Check permanent magnets for generating exciter field for damage and correct positioning in stator frame.

If necessary, the entire stator frame is to be replaced.

Continue: II08/1

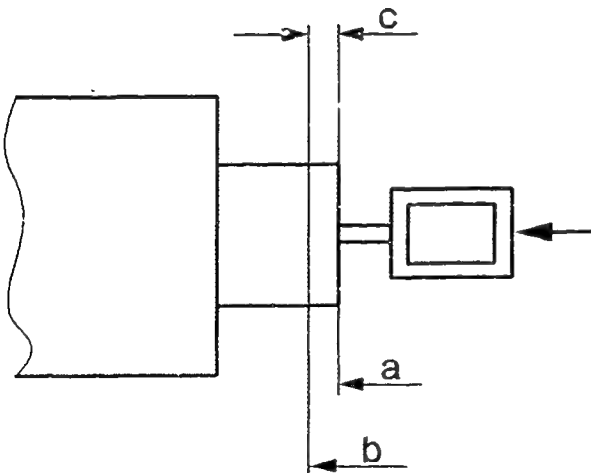
## COMPONENT TESTING AND REPAIR

### Testing solenoid switch

Examine solenoid switch for damage. Check burn-off reserve. Press in armature by hand until current bridge is resting (a) on terminal stud. On pressing in the armature further as far as stop (b) a noticeable increase in force is apparent. The difference between positions (a) and (b) is the burn-off reserve (c). If there is no further burn-off reserve, the solenoid switch must be replaced.

Continue: III03/1 Fig.: III02/2

KMS00375



# COMPONENT TESTING AND REPAIR

## Checking solenoid switch

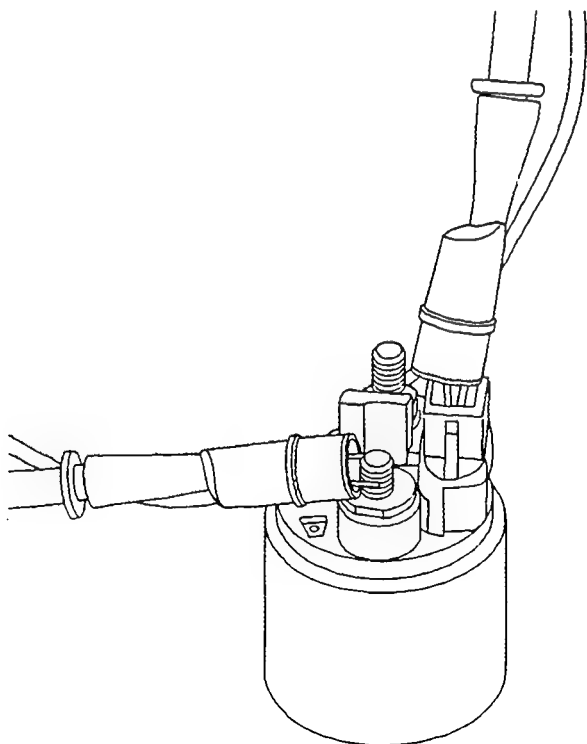
Use tester to check resistance of pull-in winding (term. 50/term. 45).

Alternator tester: 0 684 201 200

Pull-in winding resistance: 0,3...0,4 Ohm

Continue: III04/1 Fig.: III03/2

KMS00426



## COMPONENT TESTING AND REPAIR

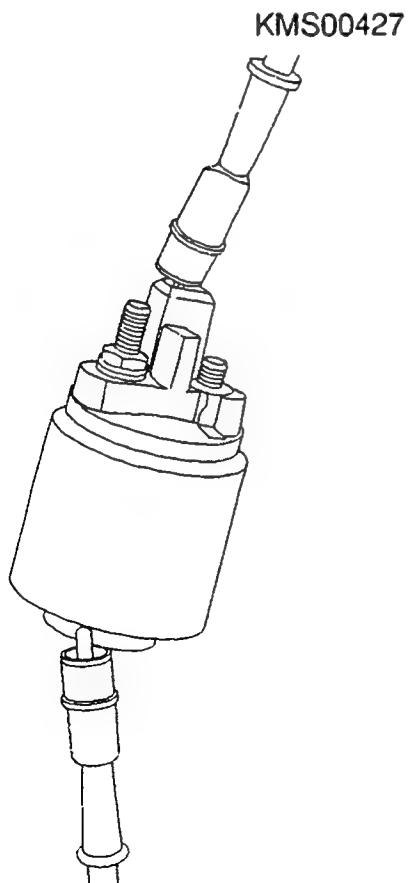
### Checking solenoid switch

Use tester to check resistance of holding winding (term. 50/ground).

Alternator tester: 0 684 201 200

Holding-winding resistance: 1,5...1,7 Ohm

Continue: III05/1 Fig.: III04/2



## COMPONENT TESTING AND REPAIR

### Testing solenoid switch

Neither the tests described, nor proper functioning of the solenoid switch when testing the function of the starting motor following repairs can provide reliable information on long-term trouble-free operation of the solenoid switch.

It is therefore advisable to renew the solenoid switch when the starting motor is repaired.

Continue: I01/1

## STARTER ASSEMBLY TABLE

Assembling overrunning clutch	III07/1
Assembling armature	III13/1
Assembling drive end shield	III14/1
Assembling cap	III15/1
Assembling brush holder	III18/1
Assembling commutator end shield	III19/1
Checking and adjusting armature longitudinal play	III21/1

Continue: III06/2

## STARTING MOTOR ASSEMBLY TABLE

Bearing end plate assembly	III23/1
Checking armat. braking torque	III24/1
Checking clutch overrun. torque	III26/1
Checking total pinion travel	III28/1
Solenoid switch assembly	IV01/1
Painting starting motor	IV04/1

Continue: I01/1

## STARTING MOTOR ASSEMBLY

Assembling overrunning-clutch drive

Lubricate in line with lubrication schedule before and during starting-motor assembly. Clamp armature in clamping support.

Clamping support:

0 986 619 362

Continue: III08/1

## STARTING MOTOR ASSEMBLY

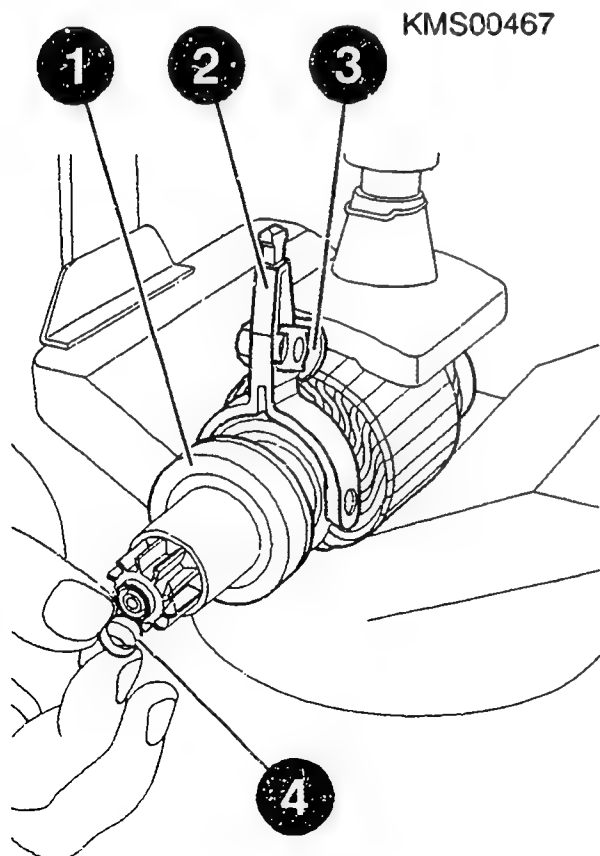
### Assembling overrunning-clutch drive

Slip overrunning-clutch drive (1) with engaging lever (2) and mount (3), as well as new stop ring (4) onto output shaft of armature.

**ATTENTION:** Spiral spline of drive must be dry and free from grease to stop output shaft becoming pasty. Only grease spiral spline on output shaft.

Grease VS 18036 Ft:                    5 997 098 000

Continue: III09/1    Fig.: JII08/2





## STARTING MOTOR ASSEMBLY

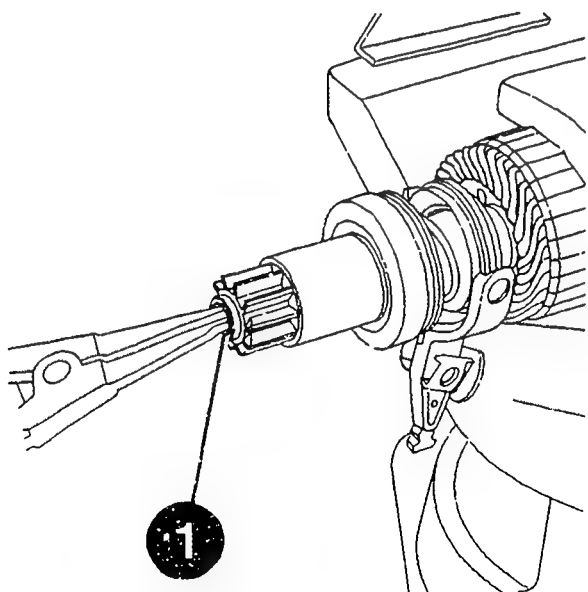
Assembling overrunning-clutch drive

Insert new snap ring (1) in annular groove.

**ATTENTION:** Take care not to damage output shaft.

Continue: III10/1 Fig.: III09/2

KMS00463



## STARTING MOTOR ASSEMBLY

### Assembling overrunning-clutch drive

Attach holding fixture (1) to pinion body (2) such that it rests on overrunning clutch (3).

Use torque wrench.

**ATTENTION:** Take care not to damage surface of body.

Holding fixture:

0 986 619 420

Torque wrench:

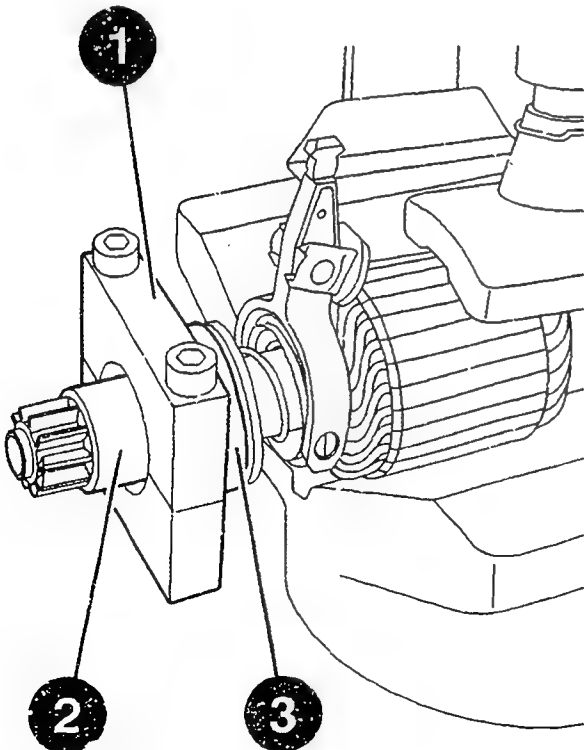
comm. avail.

Tightening torque:

25 Nm

Continue: III11/1 Fig.: III10/2

KMS00469



## STARTING MOTOR ASSEMBLY

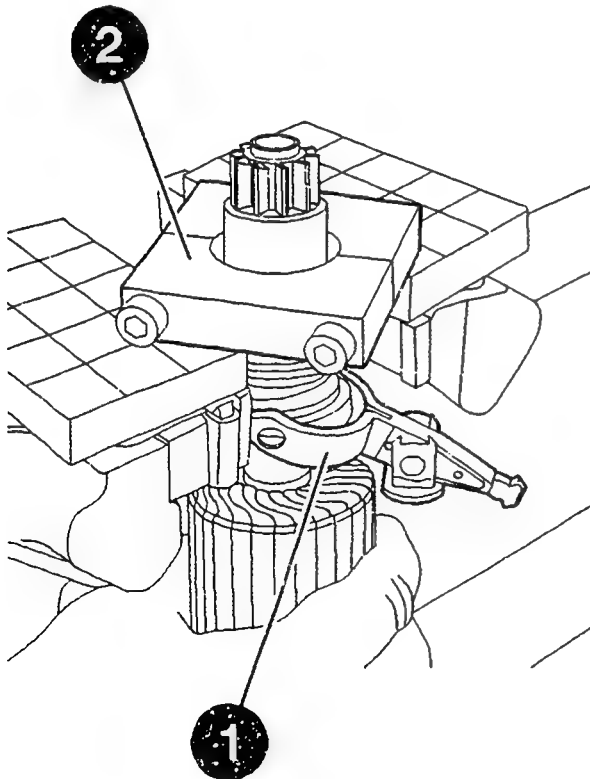
Assembling overrunning-clutch drive

Remove assembly (1) from assembly stand and position with holding fixture (2) on vice.

**ATTENTION:** Assembly must not make contact with the vice and must be freely accessible from underneath.

Continue: III12/1 Fig.: III11/2

KMS00470



# STARTING MOTOR ASSEMBLY

## Assembling overrunning-clutch drive

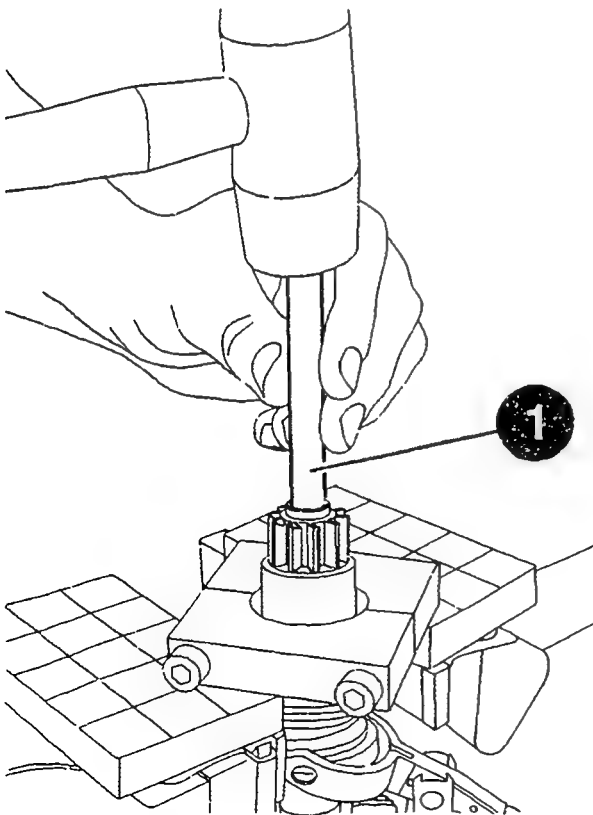
Mount tapered end of assembly sleeve (1) on output shaft.

Tap firmly (plastic-headed hammer) on assembly sleeve to engage snap ring under stop ring. Remove assembly sleeve.

Assembly sleeve:	0 986 619 417
Clamping support:	0 986 619 362

Continue: IIII06/1 Fig.: IIII12/2

KMS00471



## STARTING MOTOR ASSEMBLY

### Assembling armature

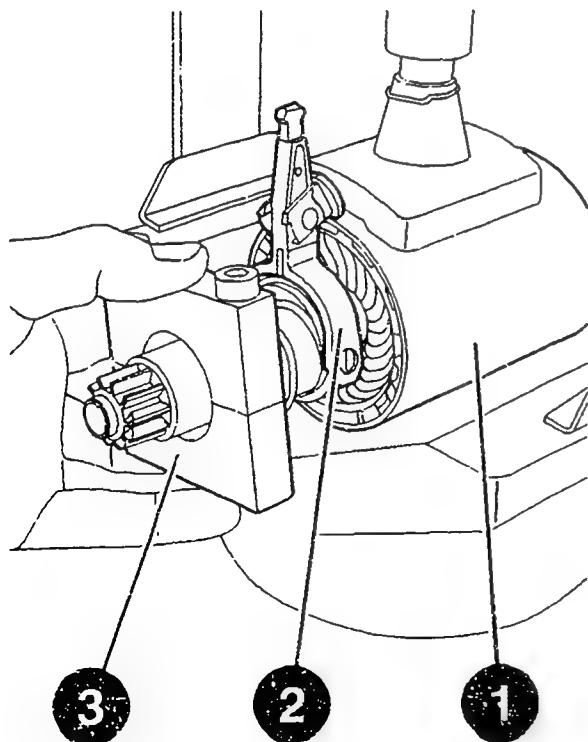
Clamp stator frame (1) in clamping support. Insert assembly (2) in stator frame from drive-end bearing side and remove holding fixture (3).

NOTE: The exciter magnetic field causes the armature to be attracted by the stator frame and held in the correct position.

Clamping support: 0 986 619 362

Continue: III06/1 Fig.: III13/2

KMS00472



## STARTING MOTOR ASSEMBLY

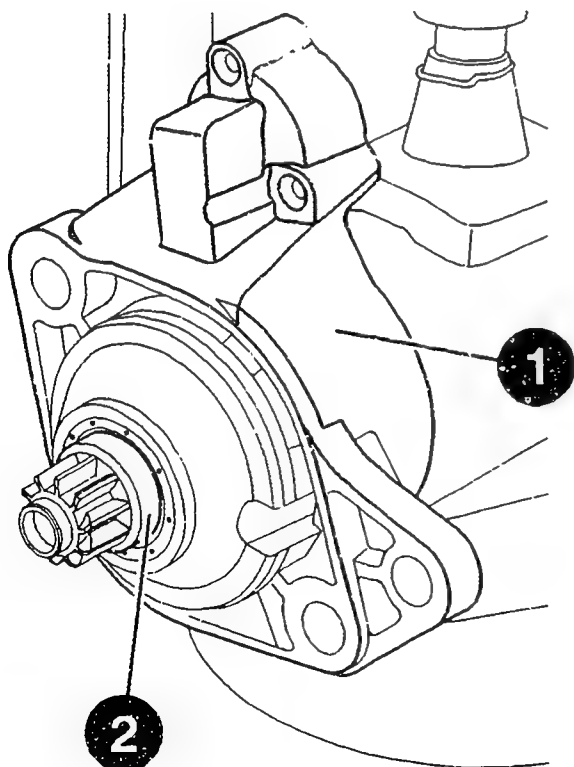
### Assembling drive-end bearing

Use three-square scraper to clean fitting surfaces at drive-end bearing.

Slip drive-end bearing (1) onto pinion body (2). Insert rubber seal in recess. Ensure correct positioning of over-running clutch drive and mount of engaging lever in drive-end bearing.

Continue: III06/1 Fig.: III14/2

KMS00528



## STARTING MOTOR ASSEMBLY

Assembling cap

### NOTE ON PRESSING ON CAP:

Slowly increase pressure whilst pressing on cap and check firmness of cap several times.

Only exert sufficient pressure to ensure firm fit of cap.

Excessive pressure could destroy components.

Continue: III15/2

## ASSEMBLING STARTER

Assembling cap

When fitting collet, make sure it is properly positioned on cap.  
On fitting, collet is therefore to be pressed slightly out of base.

Continue: III16/1

## ASSEMBLING STARTER

### Assembling cap

Carefully position assembly (stator housing, drive end shield, armature with overrunning clutch) on mandrel press.

### ATTENTION: DANGER OF INJURY

Drive end shield and armature are not fixed in position with respect to stator housing.

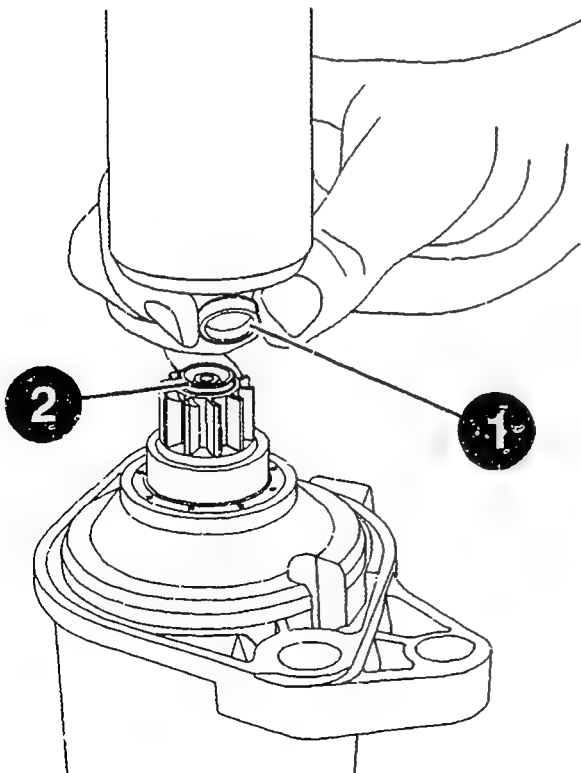
Fit cap (1) with pressed-in oil seal (2) on pinion collar.

Mandrel press:

comm. avail.

Continue: III17/1 Fig.: III16/2

KMS00526





## ASSEMBLING STARTER

### Fitting cap

**ATTENTION:** Always heed notes on pressing on.

Fit collet (1) and carefully press on cap using mandrel press. Make frequent checks on tightness of cap. Ensure correct positioning of collet. Release press, turn collet through 45 and press on again. Detach collet and check correct seating of cap.

Mandrel press:

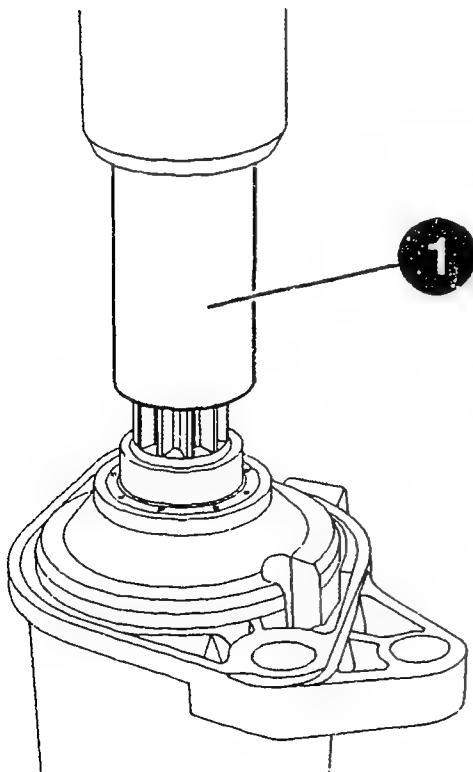
comm. avail.

Collet:

0 986 619 408/409

Continue: III06/1 Fig.: III17/2

KMS00527



## ASSEMBLING STARTER

### Assembling brush holder

Clamp assembly in clamping support.

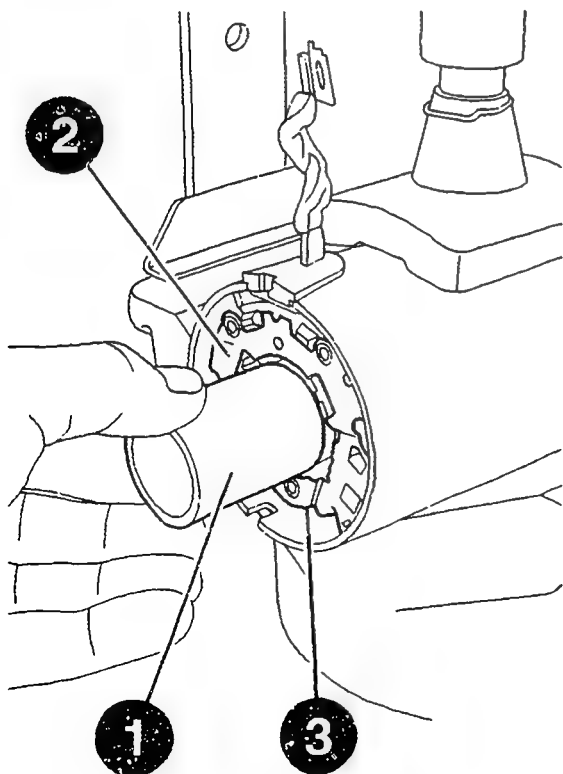
Slip brush holder (2) with centering sleeve (1) onto armature shaft from commutator end. Slip brush holder onto commutator and detach centering sleeve.

Carbon brushes must rest on commutator. Pay attention to correct positioning of locking element (3) in stator housing.

Clamping support: 0 986 619 362

Continue: III06/1 Fig.: III18/2

KMS00444



## STARTING MOTOR ASSEMBLY

### Assembling commutator end shield

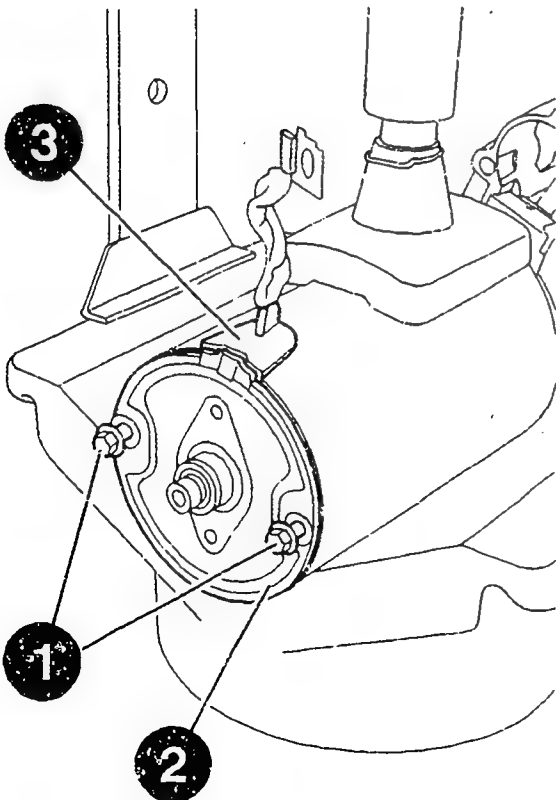
Position commutator end shield (2) on stator frame. Pay attention to correct positioning of end shield and seal (3). Slacken off clamping support, check positioning of drive-end bearing again and secure bolts (1). The bolts must run in parallel with the imaginary center axis of the starting motor. Use torque wrench.

Torque wrench: comm. avail.

Tightening torque: 5,5...6,0 Nm

Continue: III20/1 Fig.: III19/2

KMS00400



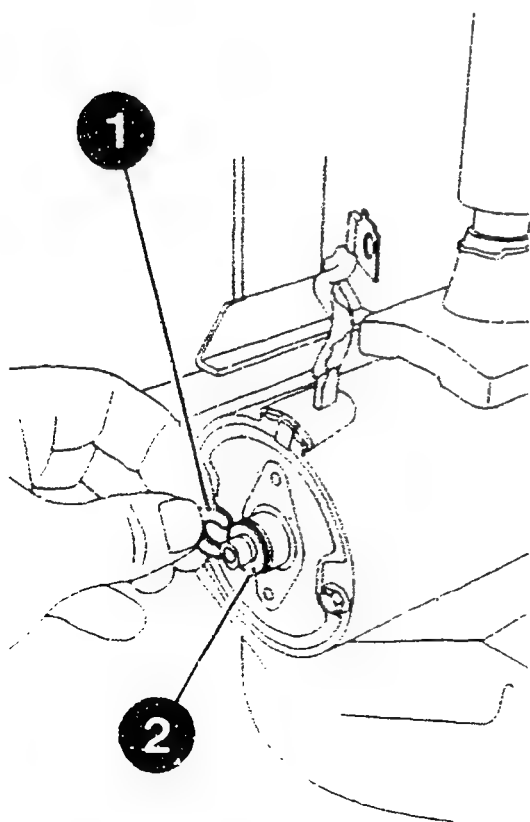
## STARTING MOTOR ASSEMBLY

Assembling commutator end shield

Slip new shim (2) onto armature shaft and insert positioning washer (1) in annular groove.

Continue: III06/1 Fig.: III20/2

KMS00399



## STARTING MOTOR ASSEMBLY

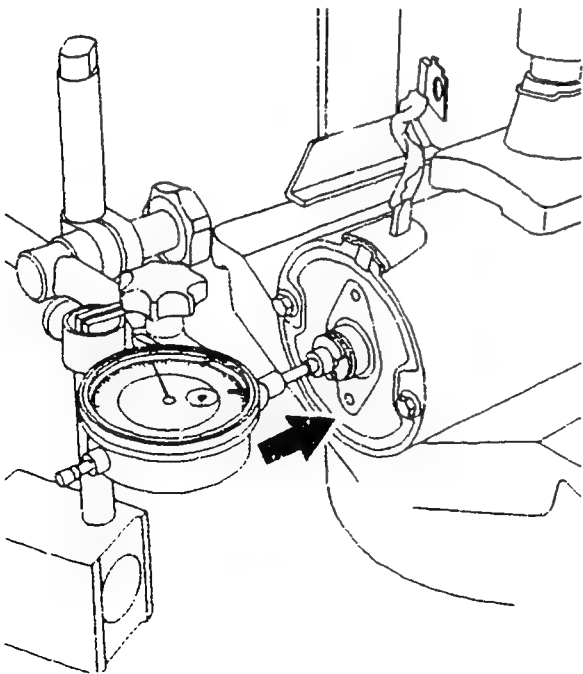
Checking and adjusting armature axial clearance

Push in armature as far as it will go in direction of drive-end bearing (arrow).

Apply dial gauge at end face of armature shaft and set it to "ZERO".

Continue: III22/1 Fig.: III21/2

KMS00447



## STARTING MOTOR ASSEMBLY

Checking and adjusting armature axial clearance

Move armature in direction of commutator end shield as far as it will go, read off armature axial clearance.

If armature axial clearance is outside stated range, adjustment must be made using an appropriate shim.

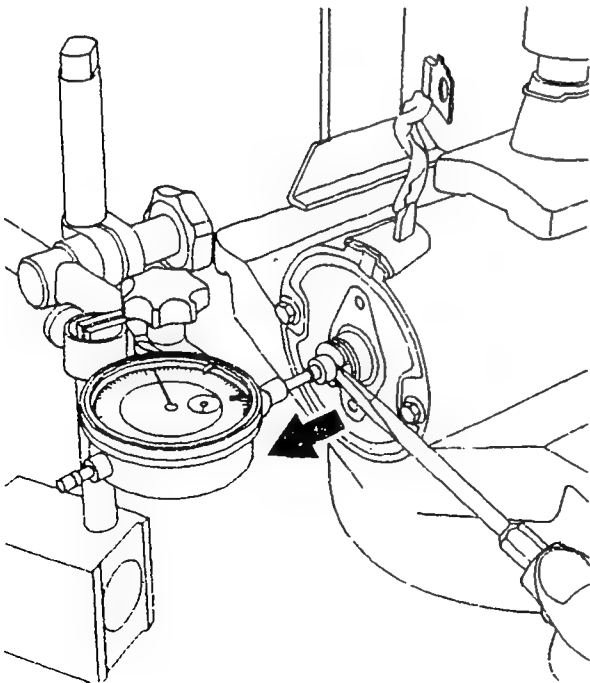
Then check armature axial clearance again.

Check freedom of movement of armature.

Armature axial clearance: 0,1...0,6 mm

Continué: III06/1 Fig.: III22/2

KMS00448



# STARTING MOTOR ASSEMBLY

## Assembling bearing end plate

Slip new gasket (1) onto commutator end shield.

Fill 1/3 of bearing end plate (2) with grease and secure.

Use torque wrench.

Torque wrench:

comm. avail.

Grease VS 18036 Ft:

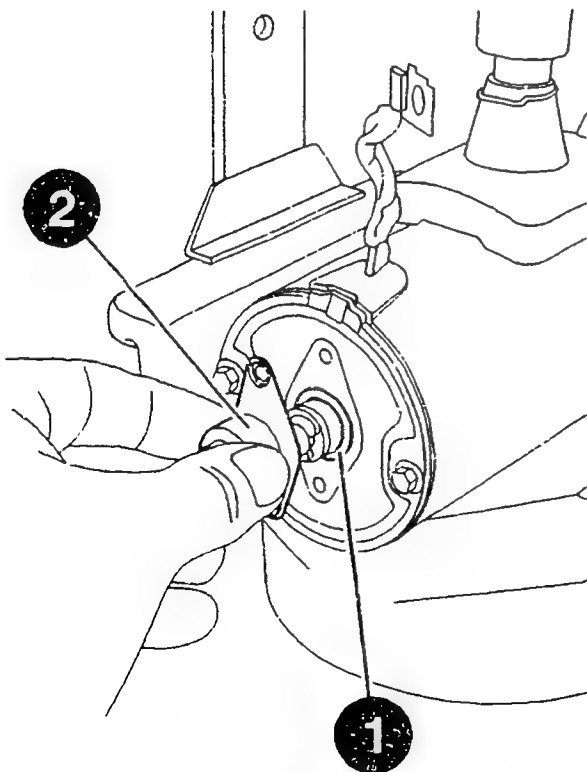
5 997 098 000

Tightening torque:

1,5...2,0 Nm

Continue: III06/2 Fig.: III23/2

KMS00449



## STARTING MOTOR ASSEMBLY

### Checking armature braking torque

Insert bolt (1), for example, in pinion so as to ensure proper attachment of torque meter.

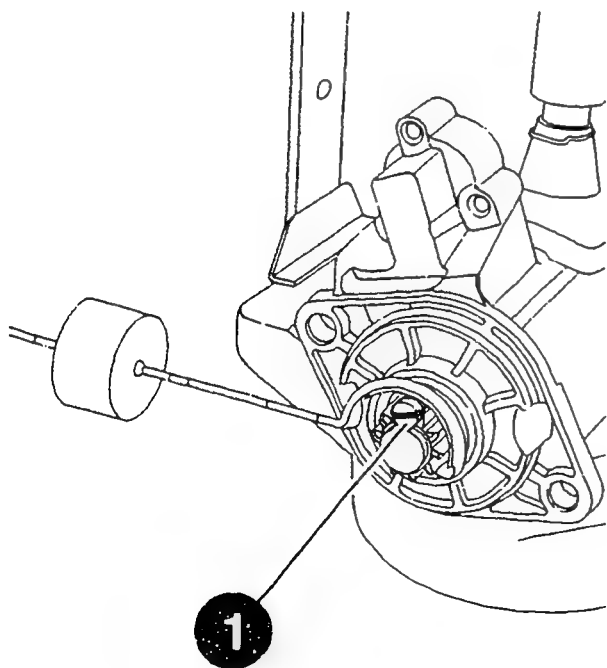
Suspend torque meter from pinion in line with direction of operation of starting motor and move to horizontal position.

Torque meter:

0 986 617 206

Continue: III25/1 Fig.: III24/2

KMS00451





## STARTING MOTOR ASSEMBLY

### Checking armature braking torque

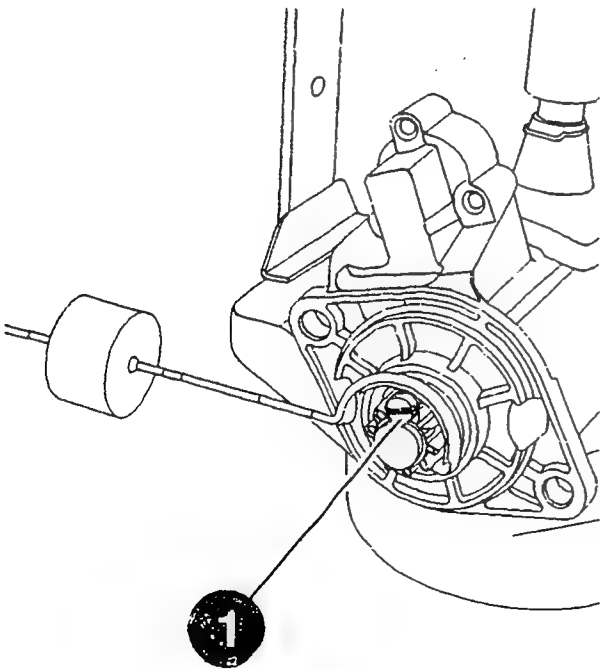
Shift weight until pinion starts to turn. Scale reading must be in range between "3,0"... "4,0", corresponding to a braking torque of 0,3...0,4 Nm.

**ATTENTION:** Torque meter must not make contact with drive-end bearing during test.

Armature braking torque: 0,3...0,4 Nm

Continue: III06/2 Fig.: III25/2

KMS00451



## STARTING MOTOR ASSEMBLY

### Checking clutch overrunning torque

Insert bolt (1) or the like in pinion to guarantee proper attachment of torque meter.

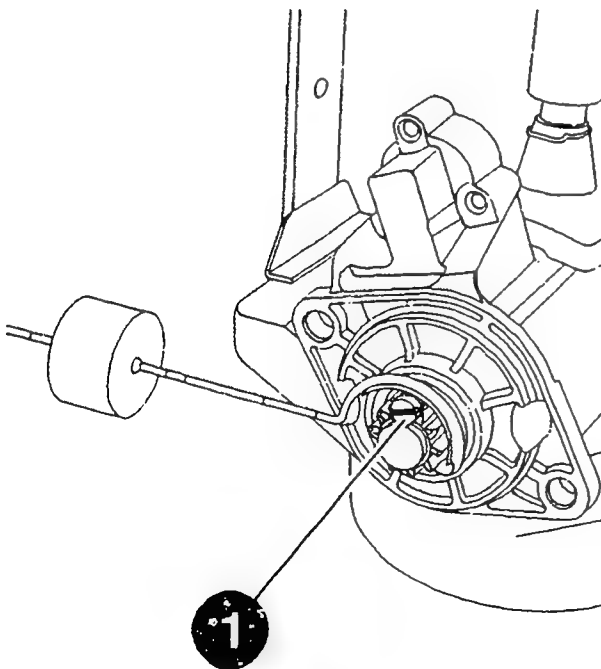
Suspend torque meter from pinion in line with direction of operation of starting motor and move to horizontal position.

Torque meter:

0 986 617 206

Continue: III27/1 Fig.: III26/2

KMS00451



## STARTING MOTOR ASSEMBLY

### Checking clutch overrunning torque

Shift weight until pinion starts to rotate. The scale reading must be between "1,0"... "2,0", corresponding to an overrunning torque of 0,1...0,2 Nm.

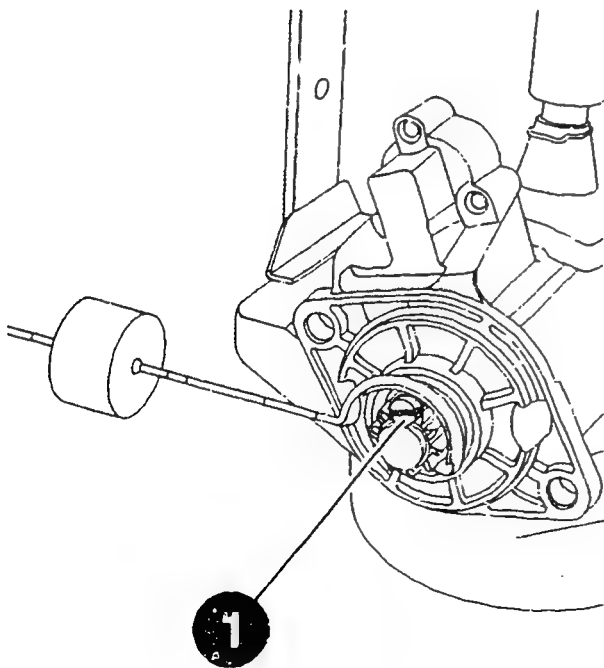
**ATTENTION:** Torque meter must not make contact with drive-end bearing during test.

Clutch overrunning torque:

0,1...0,2 Nm

Continue: III06/2 Fig.: III27/2

KMS00451



# STARTING MOTOR ASSEMBLY

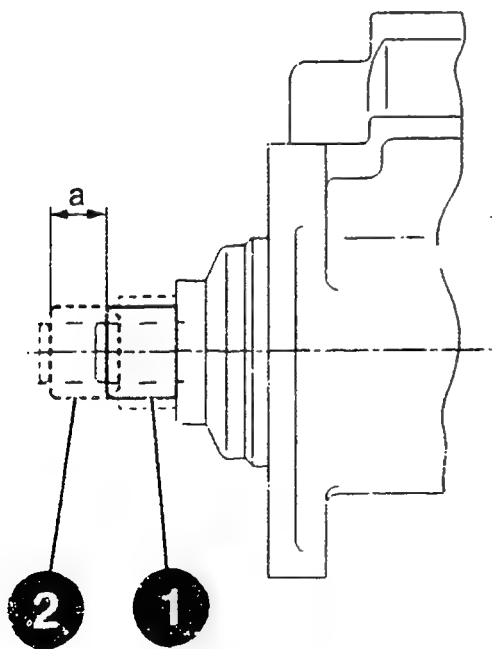
## Checking total pinion travel

The total pinion travel is to be measured at the end face of the pinion between rest position (1) and end position (2) (fully meshed).

Vernier caliper: comm. avail.  
Total pinion travel a: 12...15 mm

Continue: III06/2 Fig.: III28/2

KMS00452



## STARTING MOTOR ASSEMBLY

### Assembling solenoid switch

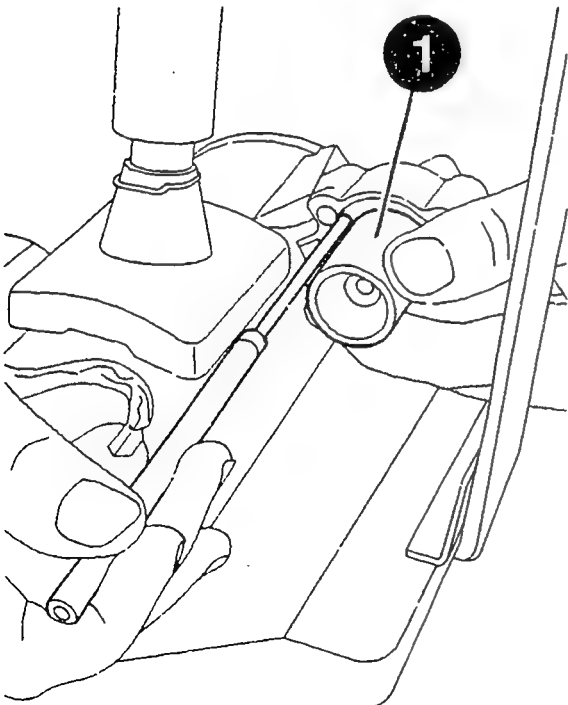
Use suitable tool to pull back engaging lever and engage solenoid switch armature (1) in engaging lever.

Apply small quantity of grease to periphery of switch armature. Pay attention to return spring in solenoid switch armature.

Grease VS 16634-Ft: 5 990 260 000

Continue: IV02/1 Fig.: IV01/2

KMS00397



## STARTING MOTOR ASSEMBLY

### Assembling solenoid switch

Slip on solenoid switch and attach to drive-end bearing.

Make sure return spring is properly positioned in solenoid switch.

Pay attention to mark.

Use torque wrench.

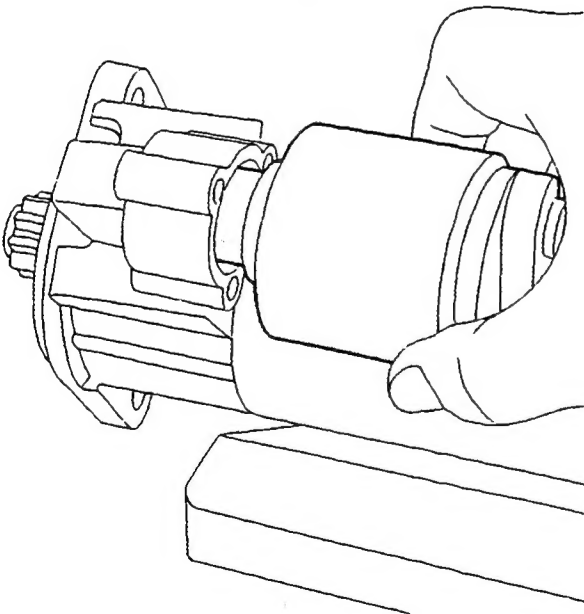
Apply approx. 0.5 g of Loctite 577 (5 994 090 000) to threads of bolts.

Torque wrench: comm. avail.

Tightening torque: 4,5...6,0 Nm

Continue: IV03/1 Fig.: IV02/2

KMS00396



## STARTING MOTOR ASSEMBLY

### Assembling solenoid switch

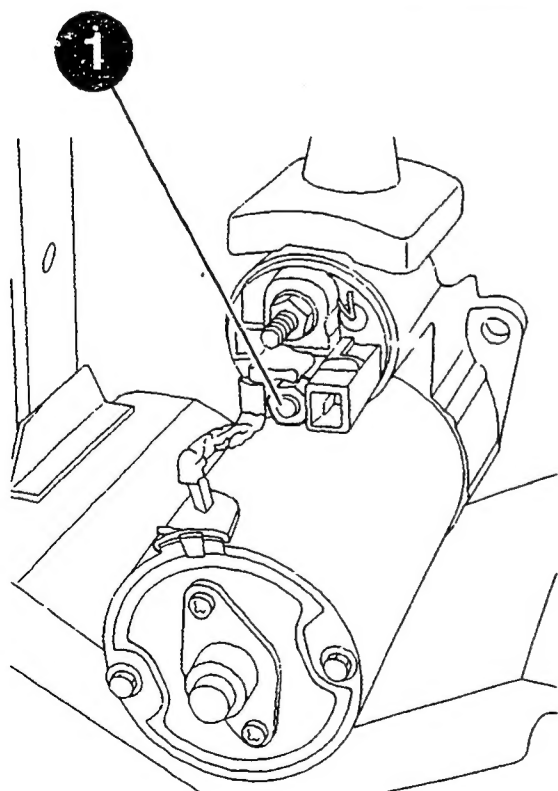
Attach connection of brush holder (1)  
to solenoid switch, terminal 45.  
Use torque wrench.

Torque wrench: comm. avail.

Tightening torque,  
term. 45: 7,0...9,0 Nm

Continue: IIII06/2 Fig.: IV03/2

KMS00395



## STARTING MOTOR ASSEMBLY

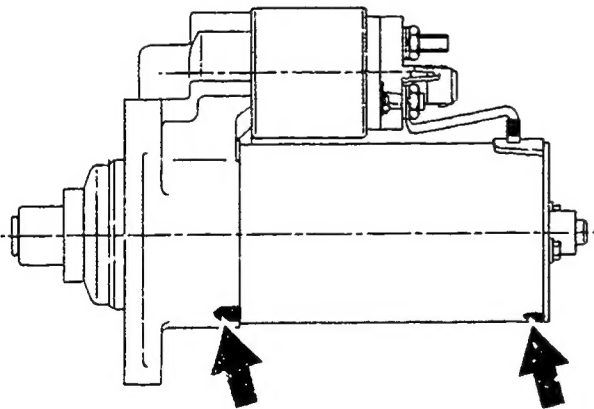
### Painting starting motor

If starting motor is painted after assembly, make sure that paint does not ingress into the interior of the starting motor through the vent holes (see arrows) in the stator frame and drive-end bearing.

Seal off vent holes before painting. Always re-open vent holes after painting so as to ensure proper functioning of starting motor.

Continue: I01/1 Fig.: IV04/2

KMS00453





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